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Electronics Lab— Start One for Pennies

Random Noise Generator

Hi-Fi Reception In the Fringes

EASILY BUILT METER READS CAPACITANCE FROM 1 PF TO .02 UF

See page 32

Acoustics— The Big Noise

FULL SCALE MMFD
20
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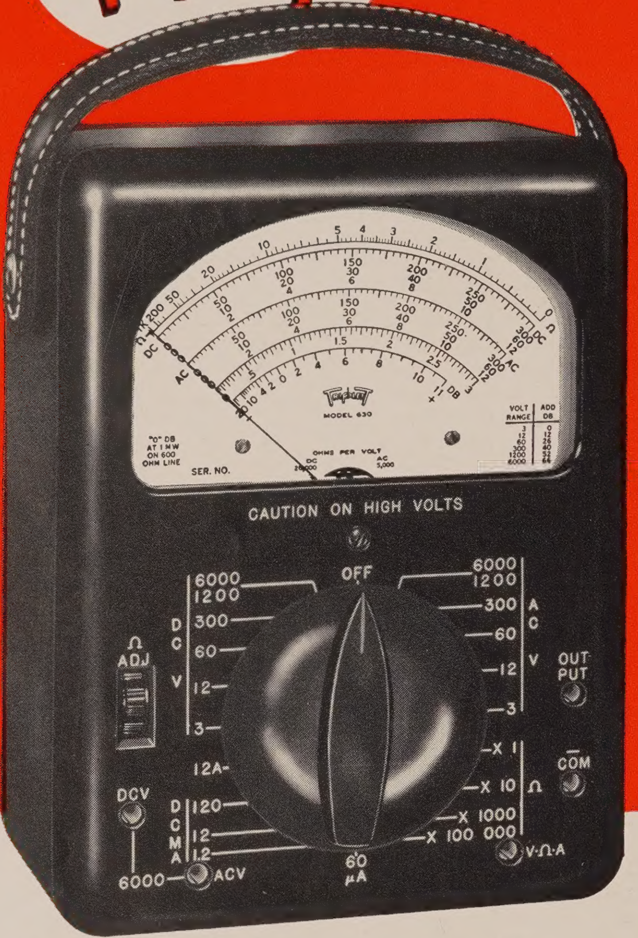
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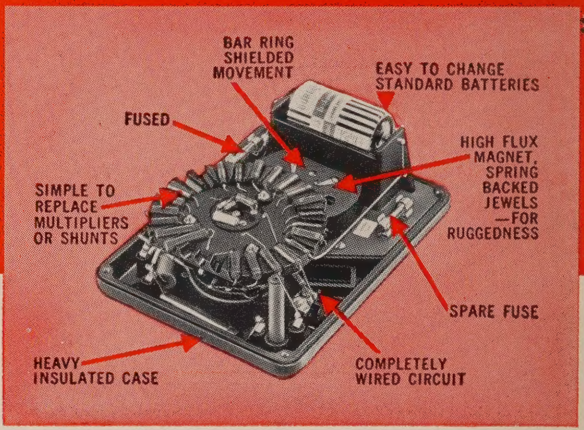
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†630A same as 630 plus 1½% accuracy and mirror scale only $59.50

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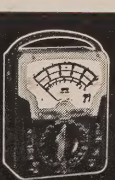
DB: −20 to +77 (600 ohm line at 1 MW).

OUTPUT VOLTS: 0-3-12-60-300-1,200; jack with condenser in series with AC ranges.

630-A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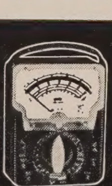
630-APL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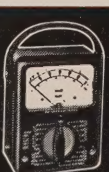
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CLATTER!
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murmur
murmur
mu
murmur
BANG!
onk! Honk!
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POP! POP
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717
NOISE CANCELLING

Electro-Voice Model 717 Noise-Cancelling Microphone $19.50 List (less normal trade discounts)

Plug a new E-V 717 into your transceiver and get up to 15 db more proection against noise pickup. Not just big noise, but every sound that reduces the effectiveness of your signal. Even the effect of poor acoustics is reduced by the 717. How does the 717 cut down on lost messages, epeated calls and wasted time and money? t has a sound-cancelling port on the back hat rejects sound arriving at the rear of the microphone. Random noise pickup is reduced up to 67%.

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**T.M. Borg-Warner*

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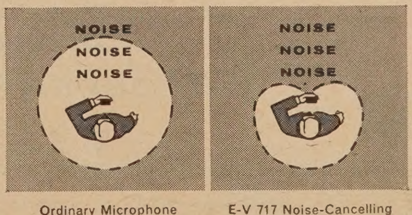
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SETTING NEW STANDARDS IN SOUND

AUGUST 1963 VOL. XXXIV NO. 8

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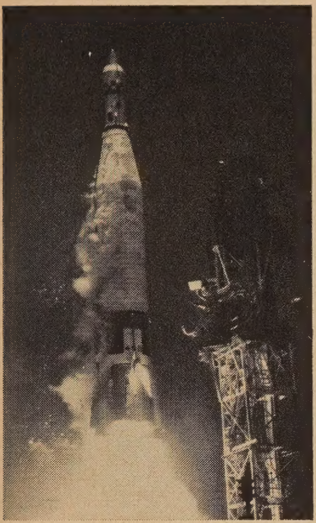

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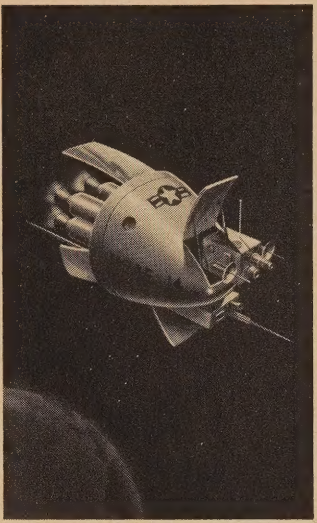

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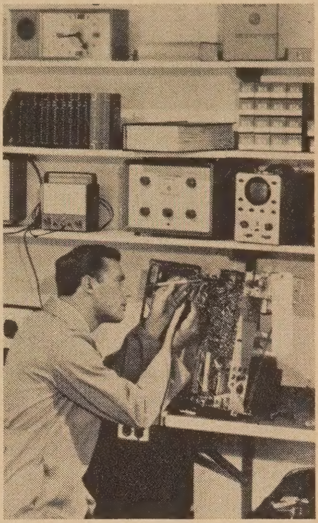

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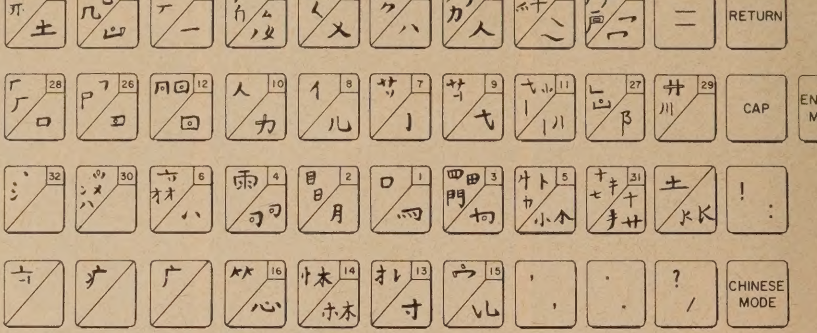
NEWS BRIEFS

Machine Translates Chinese

An experimental machine for translating Chinese to English automatically has been demonstrated by IBM. Besides the usual problems of machine translation, largely solved in IBM's Russian-translating equipment (RADIO-ELECTRONICS, July 1960, page 8), Chinese presented a special problem in the encoding of characters. The reader of a Western language finds it impossible to put the large number of Chinese characters into "machine language". The problem is solved by a special classifying system which follows the method developed by Chinese author and inventor Lin Yu-Tang, who used it in developing a Chinese typewriter. The system depends on recognizing a characteristic portion of the top of each character and another characteristic portion of the bottom. The operator, using a conventional typewriter having a special keyboard, presses the two keys containing the characteristics of the word to be encoded. However, more than one character may have these characteristics, and on tapping the second key, all the characters (never more than eight) which fit the description are projected on a screen in front of the operator. Each of these characters is numbered, and the operator finishes the encoding by tapping a third key bearing the number of the desired character. Once the machine has received the code for the word, translation proceeds as in other language-translation equipment.



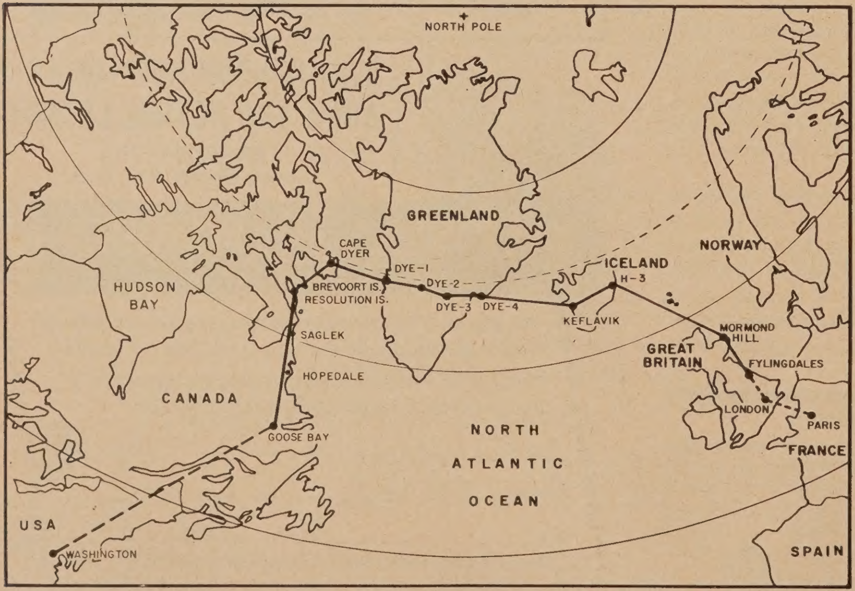
Keyboard layout of the Chinese translation encoder.

Tropospheric Telephone Spans Atlantic

The first public demonstration of trans-Atlantic voice communication by multichannel tropospheric-scatter radio took place as part of the opening ceremonies of the 17th Annual Armed Forces Communications & Electronics Association (AFCEA) Convention. Conversations between Brig. Gen. J. Francis Taylor, Jr., vice president of AFCEA in Washington; Lieut. Col. J. C. Posey in London, president of the AFCEA London Chapter; AFCEA national president Frank A. Gunther, president of Radio Engineering Laboratories, Inc., who built the equipment, and others, marked the event.

Tropospheric scatter has long been considered a possibility for wide-band intercontinental communication ("Worldwide Television," RADIO-ELECTRONICS, September 1956, page 37) and has been informally used by the United States Air Force since the middle of 1962.

The route taken by the trans-Atlantic tropo signals is shown in the illustration. From Washington to Goose Bay, transmission was by conventional telephone lines. From there to London, transmission was in a series of 13 tropospheric hops.



The route of the trans-Atlantic AFCEA tropo phone call.

Four TV Cameras On New Research Vessel

Fishery research vessel Albatross IV, newest addition to the nation's fishery and oceanographic research craft, carries four closed-circuit television cameras. Three of them are used to provide visual communications for operations aboard

(*Continued on page 10*)

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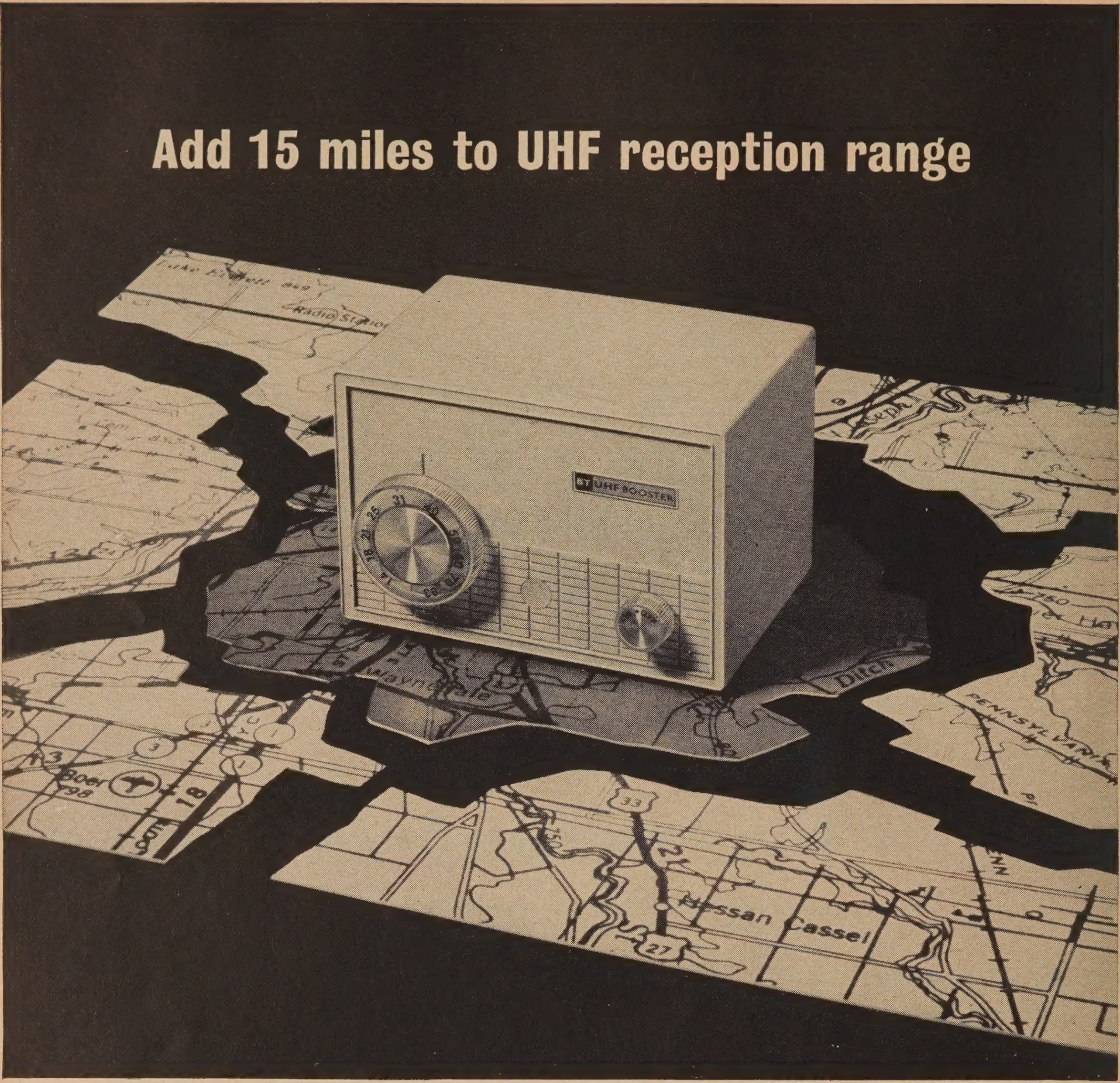

First All Channel UHF Booster—Blonder-Tongue U-BOOST

The fabulous new Blonder-Tongue U-Boost adds up to 15 miles to the UHF reception range. Homes formerly out of the range of UHF can now receive sharp, clear reception. The U-Boost will also clean up and improve fuzzy TV pictures in weak UHF signal areas, making them sharp and clear.

The U-Boost (gain 10 db) triples the antenna signal voltage. Teamed up with any UHF converter, or added to an all-channel receiver, the U-Boost improves reception on any UHF channel 14 to 83. Just a turn of the dial pinpoints the desired channel and brings it in sharp and clear. The TV picture quality is always excellent with the U-Boost, since it amplifies the signals before conversion, delivering the best signal-to-noise ratio.

Installation of the U-Boost is easy. It has an AC convenience receptacle; patented 300 ohm stripless terminals make it a cinch to connect twin lead without stripping or splicing.

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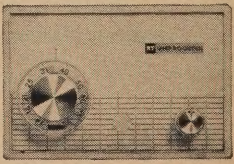

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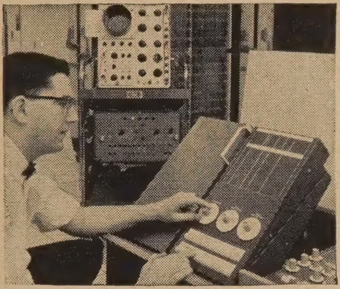

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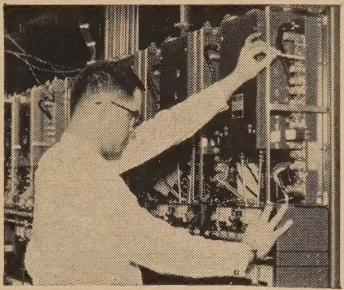

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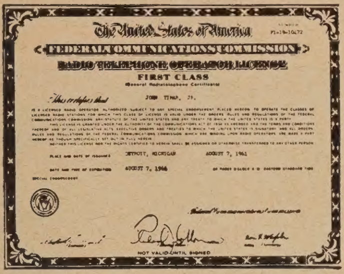

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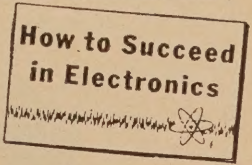
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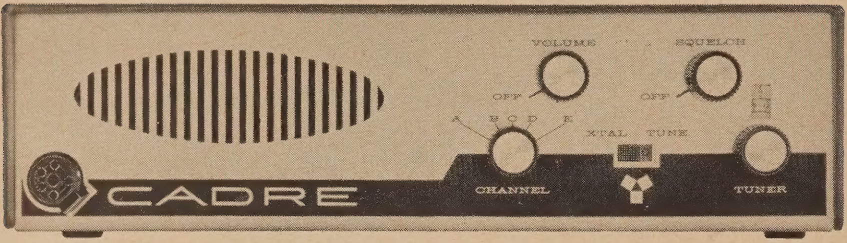

POWERFUL—5-watts, 5-channel crystal-controlled channels, 100% all-transistor, the Cadre series of transceivers can be used in any vehicle, boat or office. They deliver sharp, clear reception over the greatest transmission range possible in the 27 mc citizens band. Five fixed crystal-controlled channels spell accurate, fast communication contact. Sensitive dual superheterodyne circuit responds to weakest signals. Tuned ceramic filters increase selectivity. Reception is clear, free of noise—automatic noise limiter defeats ignition noise; adjustable squelch eliminates annoying background signals. Extended range AGC provides uniform audio output. Solid state circuitry throughout means no heat problems, no tubes to burn out, ability to withstand vibration and shock, negligible current drain, compact size.

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CADRE '515'—AC/DC transceiver can be used anywhere. $194.50
CADRE '510'—AC/DC unit. Offers 23 channel manual tuning. $209.95
NEW! CADRE '520'—DC only with DC power cord and mounting kit—ideal for mobile and portable use—operates from 12 volt auto battery or special battery pack. $187.50
NEW! CADRE '525'—for complete field portability. Standard AC cord permits recharging of two built-in nickel-cadmium batteries, telescoping antenna, aluminum carrying handle. $269.95

PORTABLE—Power is only a part of the story with Cadre transceivers. These units go anywhere—operate anywhere. An optional accessory, (Cadre 500-1 Portable Pack) adapts Cadre 510, 515 and 520 for field use. The Portable Pack is a lightweight case which contains rechargeable battery supply (two 500-2 nickel cadmium 6-volt batteries). These units can be used for base or mobile application as well as in the field. Cadre 5-watt models in the Portable Pack weigh less than 9 lbs. Cadre 500-1, $29.95, Cadre 500-2, $10.95.
For the finest CB transmission anywhere, rely on Cadre. For literature write:

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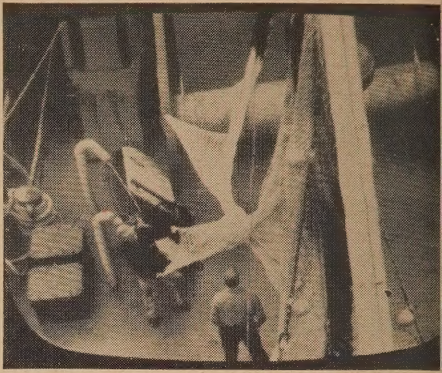
Canada: Tri-Tel Assoc., Ltd., 81 Sheppard Ave. West, Willowdale, Ont. **Export:** Morhan Exporting Corp., 485 Broadway, New York 13, N. Y.

(*Continued from page 6*)

ship, and to insure safety for the ship's crew and the 16 scientist passengers.



In a typical view on an Albatross IV monitor screen above, ship's personnel are seen rigging an otter trawl net. Below, a member of the scientific team watches a haddock picked up by the underwater camera.

Bureau of Commercial Fisheries

A fourth camera is remotely controlled for underwater observation, using an RCA industrial type vidicon that works well with low light levels. The remote camera, with its cable connection to the ship, goes overboard inside a large trawling net. The scientists use it for TV viewing or for taking a series of still pictures of underwater life.

The system also includes a low-power TV transmitter that makes it possible to pick up the images with portable receivers anywhere on the weather decks. The pictures may also be received on six wired-in video monitors, including one at the control console. This is in the ship's wheelhouse, where the operator selects which of the cameras to put on the air.

Language Labs Oversold?

As a result of a study of 21 school districts, Raymond F. Keating, research fellow of the Institute of Administrative Research, a teachers' college, concludes that the language laboratory has been oversold to the public and teachers as a "wonder

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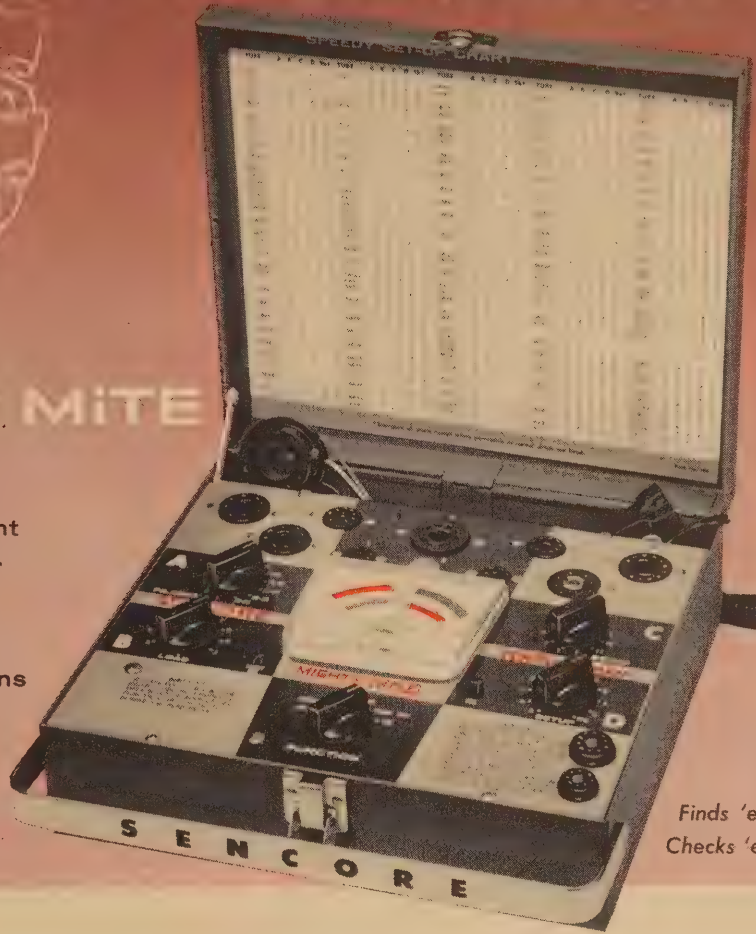

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Mighty Mite also has larger, easy-to-read type in the set-up booklet to insure faster testing. Why don't you join the thousands of servicemen, engineers, and technicians who now own a Mighty Mite tube tester? Tube substitution is becoming impossible and costly with nearly 2000 tubes in use today. Ask your authorized Sencore Distributor for the New Improved Mighty Mite. Size: 10¼" x 9¼" x 3½". Wt. 8 lbs.

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B	Industrial and Communications Electronics (V-7)	2 yrs. High School with Algebra, Physics or Science	Day 1½ yrs. (N.Y., L.A.) Eve. 4½ yrs. (N.Y.) Eve. 3 yrs. (L.A.)
C	Electronics and Television Receivers (V-3)	2 yrs. High School with Algebra, Physics or Science	Day 9 mos. (N.Y., L.A.) Eve. 2¼ yrs. (N.Y.) Eve. 1½ yrs. (L.A.)
D	Electronic Drafting (V-11, V-12)	2 yrs. High School with Algebra, Physics or Science	Eve. Basic: 1 yr. (N.Y.) Advanced: 2 yrs. (N.Y.)
E	Automation Electronics (V-14)	Radio Receiver and Transistor Background	Sat. 44 wks. (N.Y.) Eve. 9 mos. (N.Y.)
F	Digital Computer Electronics (V-15)	Radio Receiver and Transistor Background	Sat. 30 wks. (N.Y.) Eve. 6 mos. (N.Y.)
G	Fundamentals of Computer Programming (CP-1)	College Grad. or Industry Sponsored	Sat. 15 wks. (N.Y.) Eve. 3 mos. (N.Y.)
H	RCA 301 Computer Programming (CP-2)	CP-1 or Equivalent	Sat. 15 wks. (N.Y.) Eve. 3 mos. (N.Y.)
I	RCA 501 Computer Programming (CP-4)	CP-1 or Equivalent	Sat. 15 wks. (N.Y.) Eve. 3 mos. (N.Y.)
J	IBM 1401 Computer Programming (CP-3)	CP-1 or Equivalent	Sat. 15 wks. (N.Y.) Eve. 3 mos. (N.Y.)
K	Color Television	Television Background	Eve. 3 mos. (N.Y., L.A.)
L	Transistors	Radio Background	Eve. 3 mos. (N.Y., L.A.)
M	Technical Writing	Electronics Background	Eve. 3 mos. (N.Y.)
N	Preparatory (P-1)	1 yr. High School	Day 3 or 6 mos. (N.Y.) Day 3 mos. (L.A.)
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drug". Many schools, he found, were doing as well or even better without language labs.

Educators were quick to point out that all school systems surveyed by Keating were far above the average in wealth, and might be expected to have competent teachers in all the languages considered. That this must be far from the case in many schools is indicated by the fact that only two states require actual proof of a language-teaching candidate's proficiency in the spoken language. Thus a large number of classes learn foreign language translation and grammar in a dialect intelligible to no one outside the class.

Language laboratories also point out that it is a serious mistake to purchase laboratory equipment without training teachers in the proper ways of integrating the new methods of instruction into the teacher's program. Once that is done, the laboratories can be "a promising supplement to teachers of foreign languages, if properly used."

Du Mont Forecasts Television for Blind Persons

Speaking at the Third International Television Symposium (Montreaux, Switzerland), Dr. Allen B. Du Mont of Du Mont Laboratories (Div. of Fairchild Camera & Instrument Corp.) stated that future TV systems will bypass the human eye, and enable the blind actually to "see TV.

"Outstanding electronic scientists," said Dr. Du Mont, "are firmly convinced that we will be able eventually to feed electrical waves directly to the human brain . . . with such precision that . . . a blind person will actually enjoy television pictures."

In the same address, Dr. Du Mont predicted that the use of microcircuitry and improved display devices would reduce the size of future television receivers, so that "we will, without doubt, see very small, compact television receivers—small enough to fit into one's side-pocket or a lady's purse—similar to the small transistor radio of today."

TV, Radio Astronomy Struggle for Channel 37

"Scientific research could be seriously damaged," the American Geophysical Union warns, if Channel 37 should be made available to commercial television. The reason for the statement is that an application has been made for a New Jersey TV station on that frequency.

Channel 37 is in the part of the spectrum used by the University of Illinois radio telescope (RADIO-ELECTRONICS, May 1963, p. 10).

This region is the only one in which certain radiation rings of Saturn, the frequencies from the sun and the radiation belts around Jupiter can be studied.

The FCC proposed to exclude commercial stations from Channel 37 within 600 miles of the University of Illinois station for 5 years. International scientists, however, feel that television use of the channel would represent a serious waste of a precious national resource, in view of the fact that a number of phenomena can be studied only in the 608-614-mc band. According to the National Academy of Sciences, US scientific effort in radio-astronomy could suffer seriously if the channel were devoted to entertainment.

Needle Belt Orbits

Successful experimental transmissions by reflection from the West Ford Dipole Belt have been reported by the Air Force. The belt consists of more than 400 million hairlike metallic fibers, less than 1 inch long, scattered in a thin, narrow orbital ring about 2,000 miles above the earth in a near-polar orbit. It is expected that the dipoles may

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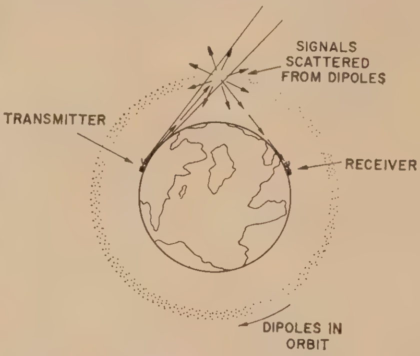
make a very effective and reliable communication circuit, since they would act as an artificial ionosphere, returning signals at the dipoles' resonant frequency, much more efficiently than could a small passive satellite.

According to the Massachusetts Institute of Technology's Lincoln Laboratory, which conducted the experiment for the Air Force, pressure of sunlight is expected to force the fibers down to lower altitudes in a few years, and they will be destroyed as they enter the atmosphere.



How the signals would be reflected from the West Ford Dipole Belt.

There was considerable objection to the West Ford Project from international astronomers, and even *The New York Times*, in a leading editorial, protested the "unilateral decision" which put the dipoles into space "without adequate international consultation."

Licenses to Cost Money

By a recent order of the FCC, a schedule of license fees will go into operation Jan. 1, 1964. For TV applications, the fee will be $100; for AM and FM broadcasters, $50. Other types of licenses for commercial and common carrier range from $2 to $100. Initial and renewal amateur applications will cost $4, and CB licenses $8.

Calendar of Events

1963 Western Electronic Show and Convention, Aug. 20–23; trade show and technical program at Cow Palace, San Francisco; other events at midtown San Francisco hotels.

NATESA Convention, Aug. 22–25; Edgewater Beach Hotel, Chicago.

7th National Convention on Military Electronics (MIL-E-CON 7), Sept. 9–11; Shoreham Hotel, Washington, D.C.

High Fidelity Music Show, Sept. 10–15; Trade Show Building, New York City.

International Radio, Television and Electronics Exhibition, Sept. 13–22; R.A.I. Buildings, Amsterdam, Holland.

35 Million Watch TV In Soviet Union

The Soviet Union's TV audience has reached 35 to 40 million, says Mikhail A. Kharlamov, the country's radio and TV chief. Writing in *Pravda* to commemorate National Radio Day, Kharlamov said 9,000,000 sets were owned by Soviet citizens, with 5,000 being sold daily. Moscow's two channels will soon be increased to five or six.

Early in May, the first link to Siberia was opened. Viewers in non-Russian-speaking areas may switch on Russian or a local-language channel for a given program.

Radio has been on the upswing during the past ten years, the chief asserted. While public loudspeakers once outnumbered household radios two to one, they are now about even, and radio broadcasts stretch from 5 am to 2 am in Moscow.

Takes Army Signal Post

Maj. Gen. David Parker Gibbs, formerly Deputy Chief Signal Officer of the US Army, became Chief Signal Officer July 1. His father, the late Maj. Gen. George S. Gibbs, was Chief Signal Officer from 1928 through 1931.

US Army

Major General Gibbs replaced Maj. Gen. Earle F. Cook, who retired from the Armed Forces June 30, after a year as Chief Signal Officer and 32 years of service.

For four months before assuming the duties of Deputy, he served as assistant to Major General Cook.

Short-Wave Listeners Hear Ham Gossip, Space News

The Voice of America is broadcasting amateur radio programs to all areas of the world at various times throughout the day. The 15-minute programs consist of ham-band gossip, interviews, propagation forecasts, technical news. Broadcasts, in English, are written and voiced by Bill Leonard, W2SKE.

Another broadcast service, "spacewarn," co-sponsored by the National Academy of Sciences, is heard on short wave 6 days a week (Tuesday through Sunday) from 0330 to 0335 GMT. It offers orbit data and radio frequencies on new satellite launchings, plus late statistics on satellites in orbit.

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Laser Transmits 118 Miles

The record for laser transmission is claimed by Electro-Optical Systems of Pasadena, Calif. Using a helium-neon gas laser with confocal mirrors, a voice signal was transmitted from a point in the San Gabriel Mountains to a receiver located 12½ miles from the town of Ballart, Calif., near Death Valley. The distance was 118 miles. The transmitter wavelength was 6,328 Angstroms, and the radiated power 125 microwatts. The message was about 300 words long. The receiver used a 12½-inch-diameter telescope as an antenna, and detected the message with an S-20 photomultiplier tube.

Diplomat's Dog Is Howling Counterspy

The State Department's most experienced electronic security specialist, inspecting the home of an overseas U. S. attache, was distracted recently by the whining of the attache's dog. The pet was "obviously in pain and appeared to be in heated combat with an invisible enemy in a corner of the room."

The security specialist lifted one of the floor slabs in the corner and found an FM radio, which was "transmitting to a distant eavesdropper all the conversations held in the room." The device was turned on and off by a sound signal too high-pitched for detection by the human ear, but annoying and painful to a dog.

The State Department, declining to state where the bugging occurred, calls the incident "The Case of the Howling Dog."

23-Inch Color Tube For Motorola TV

A Motorola spokesman states that his company will use the new 23-inch rectangular color tube now being manufactured by National Video Corp. in part of its color line, expected on the market late this summer. The new tube is rectangular, about 6½ inches shorter and about 15 square inches larger than present tubes. According to the president of National Video, its quality is comparable to any tube on the market.

TV–Radio–Phono Forecast

Nearly 9 million TV sets will be bought by Americans in 1977, predicts Frank W. Mansfield, Sylvania executive and director of EIA's Marketing Services Dept. To date, he says, we've purchased more than 86 million sets and thrown away 25 million. TV sales in 1962 totaled 6.6 million, but the figure will go down before it goes up, dropping to 6.5 milion in '63. By 1967, Mansfield says, one-quarter of America's TV homes will have more than one set, and sales will total 7 million.

Here's the rest of his forecast: Phonograph sales will grow slowly, dropping from 1962's almost 5.3 million to 5.1 million in '63, and staying there for 5 years. By 1977, sales should reach about 6.4 million. Radio sales won't go down, but will climb steadily from 13.1 million factory sales in '62 to well over 17 million in 1977.

Brief Briefs

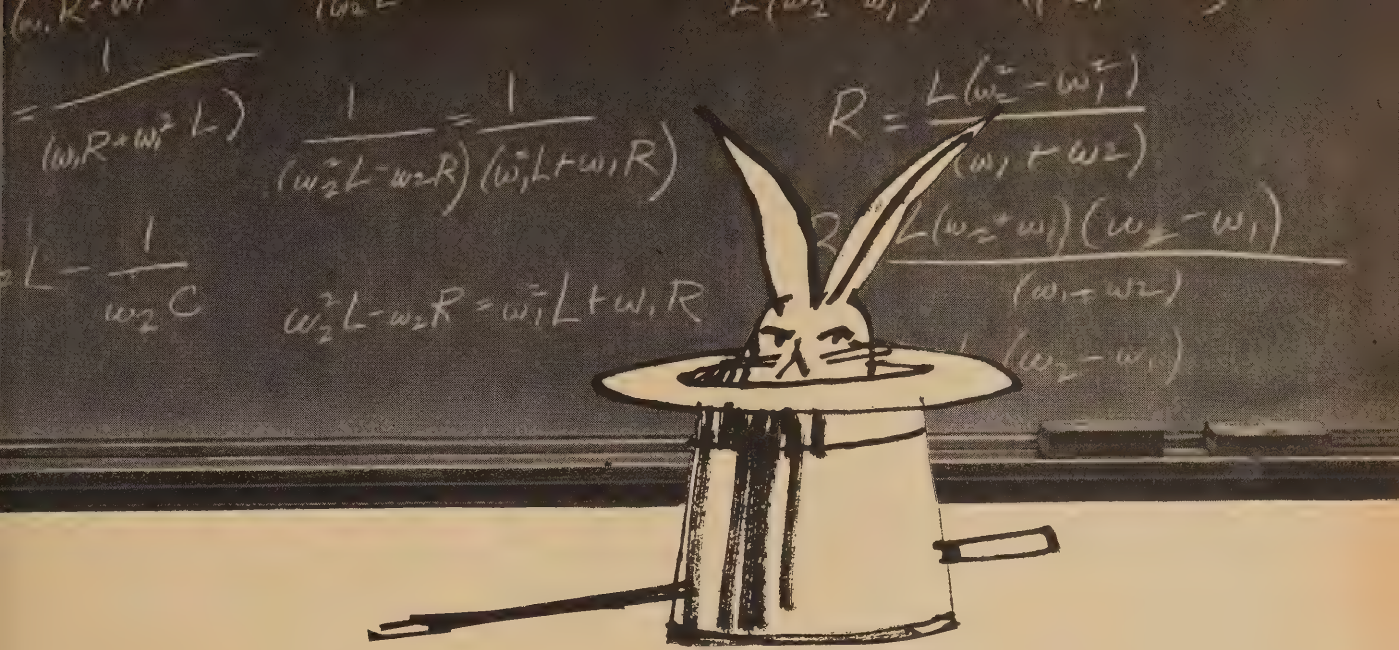
Wayne Electric Co., Harrisburg, Pa., got rid of used TV sets by placing an ad: "Used Sets—Guaranteed Not To Work." Priced at $5, $7 and $12, the sets were bought by schools, tinkerers and technicians who wanted parts.

The American housewife, buying nonfood, mass-merchandised items in supermarkets, may soon shop from electronically filled shelves. Automatic shelf and stock control, for quick replacement of fast-selling items, is predicted for 1964 by the American Research Merchandising Institute.

University of Tennessee electrical engineering student Larry Perry has applied for a patent on a TV system that makes a picture twice as wide as those now in use—like a wide-screen movie. The camera, made of subminiature components, will be smaller than current models. Mr. Perry presented his plan to the Southern Conference of the IEEE, after four years spent in its development.

A depth alarm that protects ships from shoal water has been announced by Raytheon. The alarm has its own receiver and works in parallel with the regular existing depth sounding apparatus. The returning sounding echo is amplified and measured against a preset depth. If depth equals or falls below this value, an alarm is actuated. Special filters prevent false alarms from schools of fish.

The first known transmission of facsimile with gallium arsenide diodes operating in the infrared region at room temperatures has been announced by International Telephone & Telegraph Corp. END


$\frac{1}{(\omega_1 R+\omega_1^2 L)}$
$\frac{1}{(\omega_2^2 L-\omega_2 R)}=\frac{1}{(\omega_1^2 L+\omega_1 R)}$
$R=\frac{L(\omega_2^2-\omega_1^2)}{(\omega_1+\omega_2)}$
$L-\frac{1}{\omega_2 C}$
$R=\frac{L(\omega_2+\omega_1)(\omega_2-\omega_1)}{(\omega_1+\omega_2)}$
$\omega_2^2 L-\omega_2 R=\omega_1^2 L+\omega_1 R$
$(\omega_2-\omega_1)$

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Correspondence

And We Thank You, Too

Dear Editor:

I'd like to thank you (a little late) for your 50th Anniversary issue of April 1958, commemorating *Modern Electrics.* I am now in the Air Force—in Korea—and though here I get your magazine a month old, I am still a faithful reader after almost 7 years.

When I was taking a radio–TV course, RADIO-ELECTRONICS was of vital importance in furthering my education, and in my hobby.

So I want to thank you and all the people who put such good articles in R-E. I'm sure I can speak for all your readers.

LAURENCE G. ANDERSON
Osan, Korea

Baskin on Brown on Ives

Daer Editor:

I've just read Mr. Barry Brown's letter (April 1962, page 20) criticizing Ronald Ives' "Contact Load Multiplier" article. Mr. Brown's statement that a diode across a relay coil slows the dropout time of the relay is true. However, his proposed R-C network is not the ultimate solution.

Any component shunting a relay coil will prolong the dropout time (diode, R-C network, varistor, etc.), but not for the reason given by Mr. Brown. He states that current flow through the coil in a *reverse* direction is the culprit. This is not true.

When a circuit to an inductive element (the relay coil) is opened, the magnetic field surrounding the coil collapses, causing the familiar inductive "kick". At this time, the voltage across the coil reverses polarity but the direction of current tends to remain the same.

If the energizing source could be removed completely and immediately, there would be no path for current produced by the collapsing field. This condition would produce the fastest possible drop-out of the relay.

With a shunt circuit across the coil, the collapsing field causes the coil to pump current through the shunt circuit in such a direction as to maintain the current through the coil in the same direction as the original. It is this "cir-

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HAS SERVICE BUSINESS OF HIS OWN. Don House, 3012 2nd Place, Lubbock, Texas, went into his own full-time business six months after finishing the NRI Radio-TV Servicing course. "It makes my family of six a good living," he states. "We repair any TV or Radio. I would not take anything for my training with NRI. I think it is the finest."

WORKS FOR FIRM BUILDING DC WELDERS. "Your school helped me get this job," writes Lawrence S. Cook, 529 South Bounds St., Appleton, Wis. He has also done broadcast work, TV repair, and builds custom stereo systems and medical electronic equipment. "I thought very highly of the Communications course. I still use the texts."

ELECTRONIC TECHNICIAN FOR POST OFFICE. "NRI training enabled me to land a very good job as Electronic Technician with the Post Office Dept.," reports Norman Ralston, 1947 Lawn Ave., Cincinnati, Ohio. "I finished 6th out of 139. I also have a very profitable spare-time business fixing Radios and TV."

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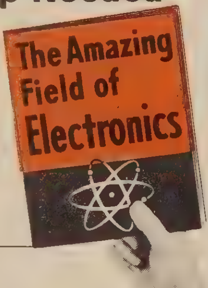

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ACCREDITED MEMBER NATIONAL HOME STUDY COUNCIL culating current" in the same direction that tries to keep the coil energized after the energizing current is cut off.

If there is a danger of a relay's inductive voltage kick causing damage to other components in a system and therefore a protective shunt *must* be used, you must expect to sacrifice quick dropout.

The simplest explanation of this phenomenon is obtained from the definition of inductance. Inductance tends to oppose any *change* in current. If current flows through a coil, the coil will try to maintain the same current within itself.

PHILIP BASKIN
Customer Engineer
IBM
New York, N. Y.

There's an Easier Way

Dear Editor:

The article "Music All Over The House—Without Wires" (June 1963) especially interested me because I wrote a similar article about 20 years ago, which you published in *Radio-Craft* magazine when I was in my teens.

My article pointed out that you can connect the output of an AM radio's i.f. amplifier to the ac line through a 0.1-μf capacitor, and then connect another AM radio's i.f. input to the line through a capacitor. The first radio will tune in the second, "all over the house."

Anyone attempting to emulate this method should be aware of the FCC's "lambda over 2 pi" requirement for unlicensed transmitters. (When I was 15 years old and experimenting with carrier-current transmission, the local FCC made me aware of this, most strongly.)

FRANK R. WILLIAMS
San Gabriel, Calif.

Latest Flash on Flash

Dear Editor:

I read with interest "Just Plain Flash" in the May 1963 issue (page 24). Some small circuit changes could increase the safety and reliability of the two units shown.

Electronic flash units can be extremely dangerous because they store large amounts of high-voltage power. A 525-μf capacitor charged to 450 volts is a great deal more lethal than smaller capacitors in radio or TV sets. Photoflash capacitors have very low leakage and can hold a charge for days. Use care in constructing and repairing electronic flash. Discharge the capacitors with a 2,000-ohm 10-watt resistor before working on such a unit.

When the power selector (S2) in Fig. 2 of the article is switched to connect more capacitors into the circuit, the fully charged capacitors discharge into the empty ones. There is nothing to limit current flow, and the switch contacts

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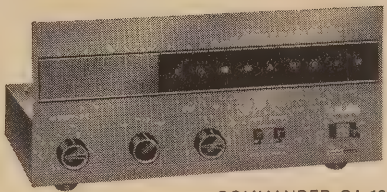
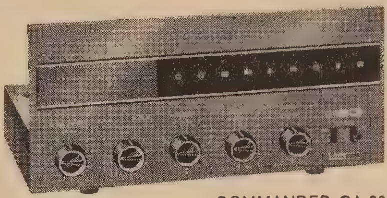

COMMANDER CA-12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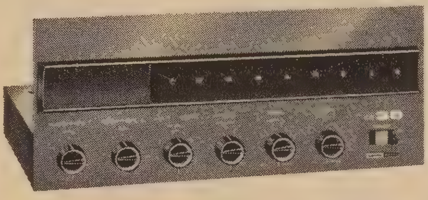
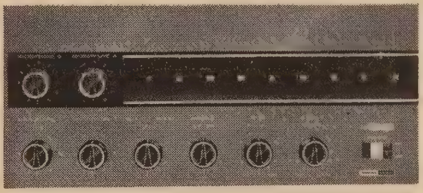
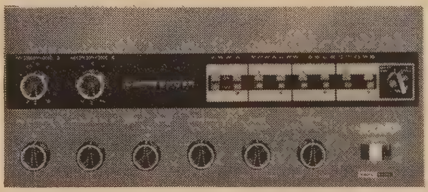

COMMANDER CA-35


COMMANDER CA-65
with extra mic pre-amp installed


COMMANDER CA-100
with extra mic channels and area selector switch assembly

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could be burned or welded together. Adding two 4,700-ohm 2-watt resistors from the negative ends of C1 and C3 to the negative end of C2 will keep some charge on all the capacitors and avoid damage to the switch.

The ac supply for the unit in Fig. 2 of the article shows a transformer supplying 250 volts at 25 ma to a full-wave bridge and then to the capacitors. The transformer will supply only about 350 volts to the capacitors. This means that on full power they will give only about 96 watt-seconds instead of 160. A transformer supplying about 320 volts ac at 50 ma or more would be better.

Because of their compact construction, photoflash capacitors are less stable than regular electrolytics. Also, they are subjected to constant charge-discharge cycles, which puts a greater than normal strain on them. The power supply in Fig. 3 of the original article shows the capacitor connected to a 510-volt battery—60 volts higher than its rated voltage. While most capacitors can take overvoltage without damage, photoflash capacitors can not. I've seen one exploded at 480—only 30 above the rated voltage.

Each of the extension heads has a .25-μf trigger capacitor. The discharge from this will definitely harm the delicate sync contacts inside the camera. Most strobes now use trigger capacitors as small as .01 μf or a thyratron trigger circuit to prevent heavy currents in the sync contacts.

TONY KARP

PhotoElectronics Co.
New York, N. Y.

Communicate Direct!

Dear Editor:

I read with interest your editorial in the May issue (page 23) on "Language Rectification". Why go about it the hard way? Let's attack it direct. Thought transfer is the direct way of communication without language distortion. Don't let messages pass through the mouth where they become distorted. Let's apply our electronic research to the exchange of "thought pictures". This would not only accelerate communications but should eliminate deception and misunderstanding.

C. B. NELIS

Aurora, Ohio

[A month ago, we would not have dared to publish a letter like this, for fear that too many might laugh. However, in view of the news item on page 12 of our June issue ("Governments Study ESP") we can assure Mr. Nelis that both the US and Russian governments (and possibly others) are investigating telepathic communication.—*Editor*]

END

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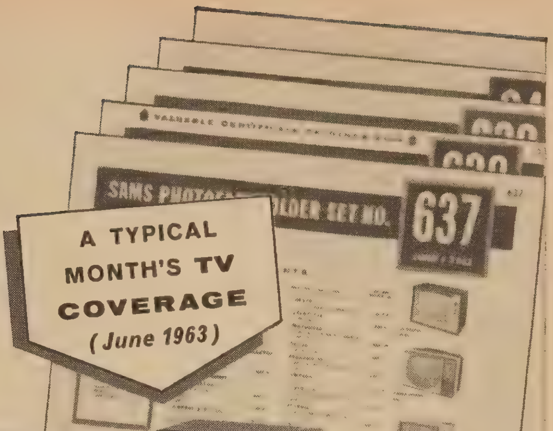

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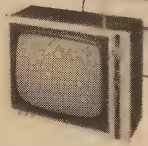

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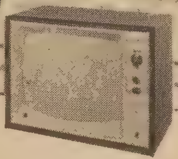

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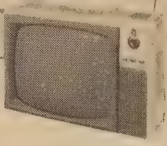

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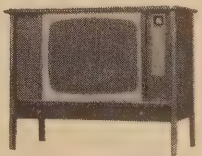
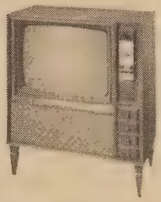


Coronado TV2-9650A



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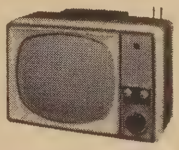

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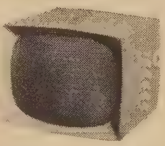
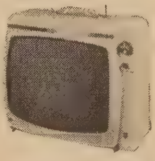
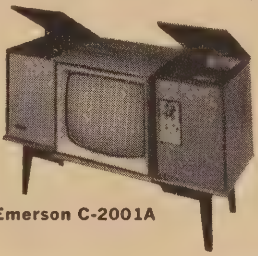


Coronado TV2-9442A

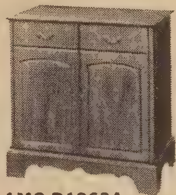


Olympic 9TV19-B

RCA Victor 213G235RV



Emerson C-2001A



AMC D1863A

Electrohome Cameo

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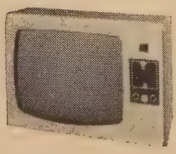
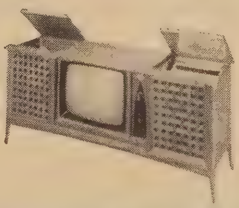


J. C. Penney 19P362A



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Beyond the performance level of these two units, possible improvement is merely marginal and very expensive. That's why with EICO's ST97 and ST70 you strike the optimum balance of cost and performance—each costs less than $100 as a kit. You can also get the ST70 and ST97 factory-wired for $149.95 each—and you couldn't find comparable wired units at the price.

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ST70 DATA: As the center of your stereo system, the ST70 accommodates all program sources. It even has separate inputs for both turntable and record changer, preamplified tape signals and tape head with correct equalization for both fast and slow tape speeds. A center channel output feeds directly on a center channel speaker or, where desired, extension speakers throughout your house without any additional amplifier. Critical parts — filter capacitors, rectifiers, output tubes—all operate well below their ratings to assure long, trouble-free life. Oversize output transformers deliver full rated power all the way down to 30 cps. . . . And as a kit builder, you'll like the spacious layout. We got rid of all those tight places. Kit $99.95. Wired $149.95 (includes metal cover).

SPECIFICATIONS ST70 *Output Power:* 70 watts (continuous sine wave 35-watts per channel) *IM Distortion:* 1% at 70 watts. *Harmonic Distortion:* less than 1%. *Frequency Response:* ±½ db 10-50,000 cps. *Inverse Feedback:* 17 db. *Stability Margin:* 10 db. *Hum and Noise Level:** mag. phono —63 db; tape head —54 db; tuners, auxiliaries —78 db. (all measurements according to 1HFM standards.)

ST97 DATA: Building the ST97 FM stereo tuner requires no instruments, no critical adjustments. The front end and IF stages are fully pre-wired and prealigned. The tunable coils of the stereo demodulator are factory-adjusted. With four IF stages plus a stable, sensitive front end, the ST97 pulls in clear stereo even under fringe conditions, and EICO's filterless zero-phase shift stereo detector (patents pending) maintains reliable channel separation. EICO's unique traveling tuning eye makes tuning simple and precise. Stereo stations are automatically identified by a pilot light. Semi-kit **$99.95.** Wired **$149.95.** (Includes metal cover and FET.)

SPECIFICATIONS ST97. *Sensitivity:* 3μv (30 db quieting), Sensitivity for phase-locking (synchronization) in stereo: 2.5μv. *Full limiting sensitivity:* 10μv. *Detector Bandwidth:* 1 megacycle. *Signal-to-Noise Ratio:* −55 db. *Harmonic Distortion:* 0.6%. *Stereo Harmonic Distortion:* less than 1.5%*. *IM Distortion:* 0.1%. *Frequency Response:* ±1 db 20 cps-15 kc. *Capture Ratio:* 3 db. *Channel Separation:* 30 db. *Controls:* Power, Separation, FM Tuning, Stereo-Mono, AFC-Defeat (all measurements to IHFM standards).

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C-8

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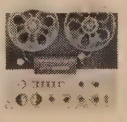
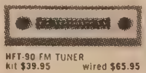
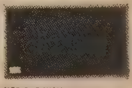


RP 100 STEREO TAPE DECK
semikit $299.95 wired $399.95



HFT-90 FM TUNER
kit $39.95 wired $65.95



HFS-6 3-WAY,
3-SPEAKER SYSTEM
kit $52.50 wired $62.50

Radio-Electronics
Hugo Gernsback, Editor-in-Chief

THE RESONANT SKY

. . . Soon Space Will Constantly Shower Us with Millions of Electronic Messages . . .

by Arthur C. Clarke

is a distinct pleasure and a great privilege to introduce our readers to ne of the foremost modern science writers of the age. Arthur C. Clarke, ho is a physicist, served in the Royal Air Force in World War II, be- oming technical officer in charge of the first experimental Ground- ontrolled Approach unit. He later assumed command for the RAF. e is a Fellow of the Royal Astronomical Society; he served twice as hairman of the British Interplanetary Society. He was also first to redict in 1945 a satellite communication system.

He is the author of 31 books, all published in the U.S. The present uest editorial is a condensation of Chapter 16, "Voices From the Sky," f his recent book **Profiles of the Future**—An Inquiry into the limits of e Possible.* It is an extraordinarily prophetic book, recently published England and the U.S. and must reading for all forward-looking elec- onics and technical readers.

H. G.

IN THE closing days of 1958, the President of the United States spoke for the first time from space. It marked the dawn of a new age of communication, which will transform the cultural, olitical, economic, and even linguistic patterns of our world.

It is simple enough to demonstrate this logically. Yet we are till, for all our ability to pluck sound and vision from the empty ir, scarcely out of the Morse-buzzer age. Within a few years, ommunications satellites beyond the atmosphere will make our resent facilities seem as primitive as Indian smoke signals, and we s blind and deaf as our grandparents before the electron tube.

Only the curious accident that the earth is surrounded by a eflecting layer—the ionosphere—makes long-distance radio pos- ible. This invisible mirror in the sky reflects waves in the broad- ast and short-wave bands, but its performance is somewhat rratic and it does not function at all on the *very* short waves.

It is the television engineer who is most badly affected by his state of affairs. TV programs go straight on out into space; hey may be picked up beautifully on the moon, but not in the ext country (on earth).

Still more serious, it is impossible to span the oceans; they emain as great an obstacle to TV as they were to the human oice before the invention of radio itself. To exchange TV pro- rams between Europe and America would require a kind of lectronic bucket chain of perhaps 50 ships moored in a line cross the Atlantic, relaying the signals from one to the other. his is not, to say the least, a very practical solution.

There is a simpler answer. Just *one* relay station will do the b—if it is in a satellite a few thousand miles above the earth. ll that would be required would be a receiver to pick up the ignals from one continent, and a transmitter to rebroadcast them the other.†

And two or three such satellites, equally spaced around our lanet, could provide TV coverage from pole to pole. The clear, lean signals coming directly down from the sky, with no back- round interference and no ghostly echoes picked up by reflection rom nearby buildings, would permit far higher standards of pic- ure quality than those we tolerate today.

To the best of my knowledge, the use of artificial satellites provide global TV was first proposed by myself in the October 945 issue of the British radio journal *Wireless World*. The scheme hen put forward, under the title "Extraterrestrial Relays," envis- ged the use of three satellites 22,000 miles above the equator. t this particular height, a satellite takes exactly 24 hours to omplete one orbit, and thus stays fixed "forever" over the same pot on the earth. The laws of celestial mechanics can thus pro- ide us with the equivalent of invisible TV towers 22,000 miles igh.

In a few years every large nation will be able to establish (or rent) its own space-borne radio and TV transmitters, able to broadcast really high-quality programs to the entire planet. There will be no shortage of wavelengths—as there is today even for local services. One of the incidental advantages of satellite relays is that they will make available vast new bands of the radio spectrum, providing "ether space" for at least a million simultaneous TV channels, or a *billion* radio circuits!

The Russians could do nothing to stop their people from seeing the American way of life. Such freedom of communication will have an ultimately overwhelming effect on the cultural, political, and moral climate of our planet. It holds danger as well as promise. If you doubt this, consider the following quite unimaginative extrapolation, which might be entitled "How to Conquer the World Without Anyone Noticing."

By 1970 the USSR will have established the first high-powered satellite TV relay above Asia, broadcasting in several languages so that more than a billion human beings can understand the programs. At the same time, in a well organized sales campaign spearheaded by demonstrations, Russian trade missions will have been flooding the East with cheap, transistorized battery-powered receivers.

But let us turn aside from the political aspects of the TV satellites and look in more detail at their domestic effects. We may see the end of the hideous antenna arrays that have ruined the skylines of all our cities and made a mockery of architecture for the last decade. The antennas of the future will be small, neat saucers or lens systems like the now familiar radio telescopes. As they will lie on their backs pointing up at the sky, they can be tucked into roofs and attics—and they will need no tottering towers to support them high in the air.

Many will look forward, with a certain malevolent glee, to the effects of outside competition upon commercial programs. At least a 100 million underprivileged Americans have never known the joys of hucksterless radio or TV; they are like readers who have become reconciled to the fact that the fifth page of every book consists of advertisements *which they are not allowed to skip*. If the Russians are clever enough to take advantage of their opportunity, they can gain an enormous audience merely by omitting the soap and laxative announcements.

The advent of global TV and radio coverage will end, for better or worse, the cultural and political isolation which still exists over the whole world, outside the great cities.

The universal communication system will have a profound impact upon language. As already suggested by me, it may lead to a single dominant tongue, others becoming merely local dialects. More probably it will result in a bi- or tri-lingual planet; in this respect, Switzerland may be the prototype of tomorrow's world.

All that has been described so far—even this last development—will result from the application of existing techniques, merely made worldwide by the use of satellite relays. It is time now to consider some of the wholly new services which will become feasible, if we wish to exploit them.

Without going into technical details, the time will come when we will be able to call a person anywhere on Earth, merely by dialing a number. He will be located automatically, whether he is in mid-ocean, in the heart of a great city, or crossing the Sahara.

Its perils and disadvantages are obvious; there are no wholly

(*Continued on page 42*)

This was written before the launching of Telstar.

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R-E reports on

TEST UR OWN TUBES
SALERNO

do-it-yourself TV repairs

Information on fix-it-yourself books and self-service tube-testers

By ARTHUR S. KRAMER

A RECENT SURVEY OF TV SET OWNERS SHOWS:

1. **28%** of TV owners have successfully repaired their sets with self-service books and tube testers.
2. **12%** tried and couldn't.
3. **60%** never attempt to make their own repairs.

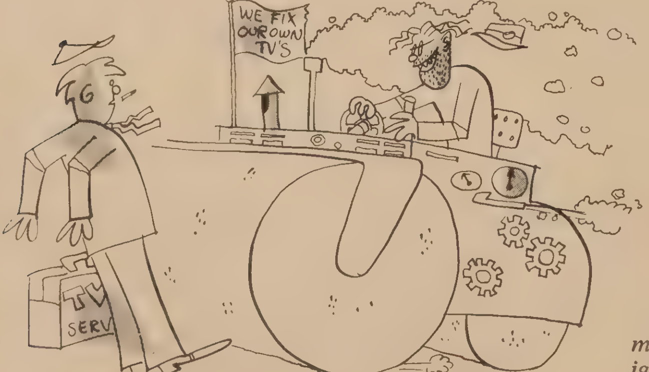
These figures indicate that this "fix-it-yourself" movement is important enough to be taken seriously. Further on, we will see why so many owners try doing-it-themselves, and some things the TV repairman can do to offset this.

The method used for the survey was not complicated. Names were selected at random from the local telephone directory, and form letters containing several questions were sent to these people. The letters were followed within a few days by telephone calls. The large majority of persons called were very cooperative and happy to express opinions. One man questioned has taken up electronics as a hobby, and gave some very valid opinions.

TV repair shop owners

Approximately 50% of TV repair shop owners and managers reported that their tube sales had been cut by self-service tube testers in drug and stationery stores. *The other 50% reported that they had felt no ill effects* from the "do-it-yourself" movement. Approximately 30% have installed their own self-service tube testers.

Here, again, the statistics show that this movement cannot simply be ignored or laughed off. Self-service tube testers and "fix-it-yourself" books are here to stay!


WE FIX OUR OWN TV'S
TV SERV

The do-it-yourself movement cannot be ignored.

Some of the side information gathered during this part of the survey is quite interesting. Speaking of the effects of self-service tube testers on tube sales, Robert Purcell of Bob's Electronics, 285 Broadway, Bethpage, N.Y., states: "These self-service tube testers have certainly cut down tube sales. Everybody is trying to save a buck! Many people test their tubes before calling the service technician. It has been my experience that self-service testers are honest. They are not rigged to make good tubes test bad."

Another TV technician with long experience in the field says: "There is no doubt that these self-service tube testers have cut our tube sales. However, I believe that this has cleared the air, so that now, when a customer brings a set into the shop, the trouble is probably not in the tubes, but is more involved. This has helped us because, in most cases, the customers have tested their own tubes and they are now fully convinced that something besides tubes is causing the trouble."

On the other side of the argument, we have the opinion of Dan Bailey of Birch Hill TV, Locust Valley, N.Y.: "I do not feel that these self-service tube testers are any great problem. I do not keep one in my place. It has been my experience that customers create many more problems by putting tubes back into the wrong sockets, or by breaking off a tube pin or socket contact, or buying tubes which they do not need. Self-service tube testers do not worry me!"

One of the TV service shops interviewed is run by two women. The owner said that she does not depend to any great extent on tube sales, and makes most repairs in the customer's home. Mrs. Burke, the owner, and Miss Kramer, her assistant, are shown in the photograph behind their workbench, in their shop, Burke's TV & Radio Repair, on Jericho Turnpike in Woodbury, N.Y.

Tube-tester manufacturers

Questionnaires were sent to a number of tube tester manufacturers, and several expressed opinions on the "do-it-yourself" movement. All who responded manufacture dynamic mutual-conductance type tube checkers, and a few also make the emission type for self-service.

All who responded consider the dynamic mutual-conductance tube checker superior to the emission type. The DMC checker tests the tube under actual operating conditions, whereas the emission type shows only the emitting capabilities of one or more of the tube electrodes. The manufacturers are evenly divided about the effect of the fix-it-yourself movement on the volume of business conducted by TV repair shops. Half feel the movement will have no effect, and the others believe serious effects will be felt. All recommend that the service shops buy their own "self-service" tube tester and make it available to customers who wish to check out their own tubes.

Most self-service tube testers are very simple to operate.

Supplementary remarks made by one very prominent manufacturer of DMC tube checkers (Hickok Electrical Instrument Co., Cleveland, Ohio) are worth reporting. In commenting on the effect of this movement on the volume of TV and radio repair business, Hickok stated: "A customer can make repairs on his television set or radio by substituting tubes; he will tend to use this method of repair and not go to the technician. However, there comes a time when mere substitutions will not do, and the average user of the 'fix-it-yourself' outlet will then turn to the service technician. Thus a technician is losing a portion of his business for a merely substituted tube but he has not lost the business that requires a very exhaustive analysis of the circuitry, reference to scopes, alignment equipment and other highly sophisticated repairs that are beyond the layman's understanding. Also, because so many of the fix-it-yourself testers are not accurate, the average user will find he is spending more money than he should and this may drive him back to the service technician.

Mrs. Muriel Burke (right) owns Burke's TV and Radio Repair, one of the shops queried in this report. With Mrs. Burke is her assistant, Miss Mary Kramer.

"It boils down to this: People who use self-service tube checkers are reacting against the fact that they once were billed for a $3.00 tube plus a service charge. The service technician can win them back by encouraging them to bring their tubes to his shop, let them come to their own conclusions about the tubes' condition and be ready to give them advice and counsel. He can thus gain back the business he lost to the corner drugstore, and be ready when major repairs are to be made."

Testers for "fix-it-yourselfers"

Many of the self-service tube testers available to the public in drug and stationery stores are big and impressive-looking. Quite a few have more than 100 sockets, numbered to correspond to a guide chart which may also tell how to set the bias control for the meter circuit. The meters on some testers are equipped with BAD–?–GOOD colored scales so that it becomes unnecessary for the user to read and interpolate the scales. Operation is very simple, and usually

FIX TV
TV REPAIR SIMPLIFIED
THE TELEVISION DOCTOR
FIND THE TUBE → CURE THE TROUBLE
$1
TELEVISION TROUBLE-SHOOTER
HOW TO ADJUST AND REPAIR YOUR SET
TV TERMS SIMPLIFIED
CONSULTING ENGINEER
TV TUBE DETECTIVE
SAVE MONEY DO IT YOURSELF
DETECTS WEAK TUBES
DIAL YOUR TROUBLE HERE
THE ORIGINAL
How You Can Fix Your Own T.V. Set
IT'S EASY! IT'S FUN! THE NEW WAY!

Some "self-help" books contain information; others are worthless.

consists of the following steps:

1. Turn the on–off switch to on.
2. Insert tube in socket as directed by instruction chart. If tube has metal cap, attach clip lead to it.
3. Set meter bias, if necessary.
4. As tube warms up, watch neon bulbs for flashing. This may indicate presence of gas or shorts.
5. Press "test" button. Meter will indicate whether tube is "good" or "bad".

For simplicity in manufacture and operation, emission type circuitry is used in self-service testers. Even with the minimum number of controls and simple operating procedure, many tubes are placed in the wrong sockets, resulting in bent pins and burnouts. Occasionally, angry users have accused the store owner of maintaining a "gyp" machine.

G
UNCLE
TV
SERVICE

Sooner or later the do-it-yourselfer must call a technician.

The writer purchased 10 late-model tubes, such as the 6CG7, 6CG8, 6BZ6, etc., and tested them thoroughly in a top-brand DMC tester. All 10 tested OK in every way. These 10 tubes were then retested in a number of self-service tube testers selected at random in the local area. Every self-service tube tester showed each of these 10 tubes to be "good" every time. In a few cases, loose socket contacts were found, but the end result was still the same. These self-service tube testers are honest! *None was found to be "rigged" or "gyp" in any way.* When used properly, they will give a legitimate emission test on any tube they are equipped to measure! About four or five makes were observed during this part of the survey.

Books and charts

Many books have been written on the general topic of "fixing your own TV set." Without exception, they never get beyond the tube-substitution stage of TV receiver repair. Most authors *tell* the reader to go no further than testing and changing tubes. If this does not clear the trouble, they then advise calling a good TV technician. The average book of this class shows a fair number of defective TV pictures, and suggests which tubes may be at fault in each case. The rest of the book is made up of chassis layout diagrams and other aids for locating the defective tubes. One enterprising publisher has devised a rotary chart of heavy cardboard. In operation, the chart is turned until the bad picture symptoms are found in one window. Another window on the chart then lists the tubes which may be at fault. A few typical faults listed: "picture blows up"; "picture jumps"; "flat heads"; "torn picture".

Conclusions and recommendations

It would seem that the self-service tube tester will be with us for a long time. However, none of the manufacturers of these devices has any plans to bring out a line of self-service transistor checkers. The consensus on this matter is that such a device would be far too complicated for the public to operate.

Quite a few people want to apply do-it-yourself philosophy to TV repair. A self-service tube tester in the TV shop maintained in good order and with no high-pressure tactics to sell tubes should go a long way toward solving this problem. Cheerful assistance and ready answers to the do-it-yourselfer's questions should eventually convert him into a regular, profitable customer. An extra touch of service would be a collection of fix-it-yourself books near the tester.

The writer gratefully acknowledges assistance from the following organizations: General Electric Co., Owensboro, Ky.; B & K Manufacturing Co., Chicago; Avnet Instrument Co., Westbury, N.Y.; New London Instrument Co., New London, Conn.; Shell Electronic Manufacturing Co., Westbury, N.Y.; Mercury Electronics Corp., Mineola, N.Y.; Hickok Electrical Instrument Co., Cleveland, Ohio, and Seco Electronics, Inc., Minneapolis, Minn. END

ADD DEPTH TO YOUR SPEAKER

One man's approach to speaker enclosures

By GLEN R. TRAVIS

WHILE WORKING ON AN AMPLIFIER RECENTLY, I had occasion to put the speaker on the floor at the end of the bench. There was little bass from this unmounted speaker, but when I lifted the speaker from the floor, the quality improved. The farther from the floor the speaker was moved, the better it sounded. The quality changed continuously as the distance between the speaker and the floor increased. The first noticeable improvement came at about 18 inches and continued to 28 inches, beyond which no further improvement was noticed.

This variation of sound quality with the distance between the speaker and the nearest reflecting surface gave me a clue to better sound. The problem was to build this distance into a practical cabinet. Ducts, baffles, horns and direct-to-air porting were tried. All caused multiple high resonances which were apparent when both listening tests and impedance curves were run on speaker-cabinet combinations. Friction loading through glass wool across the port gave resonance-free speaker-cabinet performance for low frequencies.

For comparison, cabinets from 2 to 12 cubic feet, using one or two speakers of equal size varying from 8 to 15 inches and ranging in cost from $13 to $129.50, were built, listened to and tested. Small 2-cubic foot cabinets using 8-inch speakers were experimented with first because construction was easier and

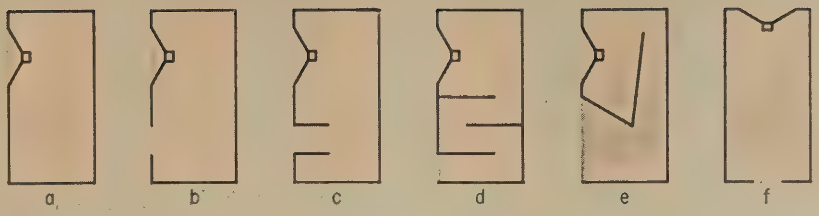


Fig. 1—Some speaker–cabinet designs author tried: a—closed; b—bass reflex; c—ducted; d—labyrinth; e—horn; f—end-mounted bass reflex.

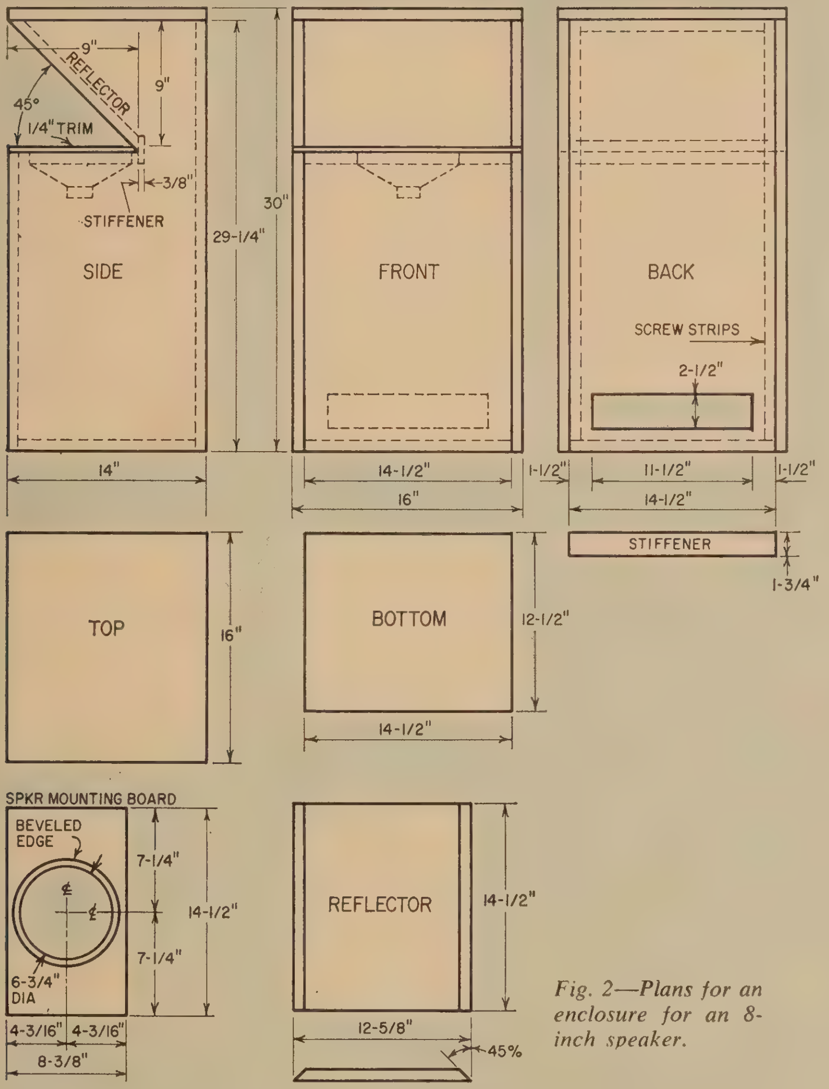


Fig. 2—Plans for an enclosure for an 8-inch speaker.

quicker. Several different speaker-cabinet combinations with identical speakers were assembled. The designs are shown in Fig. 1. The speaker-cabinet combinations were tested and listened to. The only combination that produced noticeably different and cleaner listening was the end-mounted one shown in Fig. 1-f. The first reflective surface was 22 inches from the rear of the speaker. This cabinet was the basic design of the cabinets to follow.

A typical small cabinet of this design is shown in Fig. 2. Its volume is approximately 2.2 cubic feet. Except for the stiffener securing the speaker mounting board to the reflector board, ¾-inch plywood is used throughout. This stiffener should be ⅜ inch thick. Fit all wood pieces together and check for fit before cementing. Bevel the edges at the top of the speaker mounting opening with a wood file. Glue, butt and hold joints together with wood clamps until the cement has set. Use glue blocks freely. Cover the edges of the plywood with wood tape. Secure the glass wool across the port as shown in Fig. 3. Fasten the rear panel to the ¾-inch wood strips glued to the side panels, top and bottom panel with 1½-inch woodscrews. If a separate tweeter is used, mount it either next to the speaker or on the front panel directly beneath the speaker. Speaker cone area is ported at the bottom rear of the cabinet. Loading the speaker cone through ½-inch glass wool mounted between ½-inch mesh wire placed across the port gives the speaker-cabinet combination an impedance curve similar to the typical friction-loaded impedance curve of Fig. 4. The exact curve depends upon the combination of the particular make of speaker used and the cabinet. Line all inside surfaces with glass wool or Kimsul insulation. Set the cabinet at least 2½ inches from the wall.

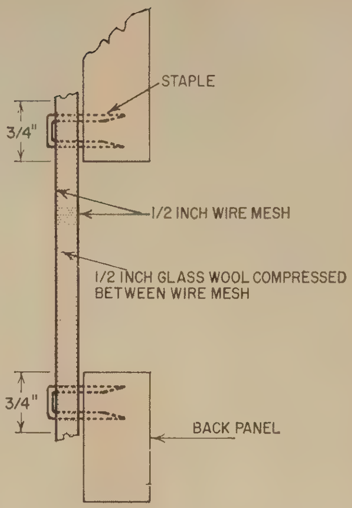


Fig. 3—Glass-wool insulation should be placed over the port in this manner.

To suit my particular taste in sound, a larger speaker-cabinet combination was required. The designs shown in Fig. 1 were tried for comparison. Dimensions were varied to give cabinet volumes of 6 to 12 cubic feet. In the end-mounted design, the distance from the speaker mounting board to the first reflective surface was kept around 28 inches. Port area should be approximately speaker cone area when friction loading is used. When friction loading is not used, the port area has to be varied to load the speaker properly. All listening and measured tests gave the same conclusions as for the smaller speaker-cabinet combinations except that the range of sound was fuller with the increased bass efficiency possible with the larger cabinet and the cleaner sound from the greater distance between the rear of the speaker and the first reflective surface.

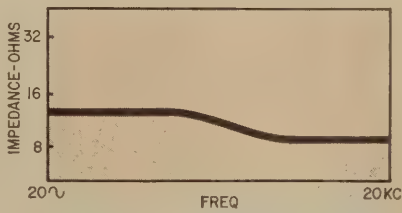


Fig. 4—Impedance curve for a typical friction-loaded speaker-cabinet combination.

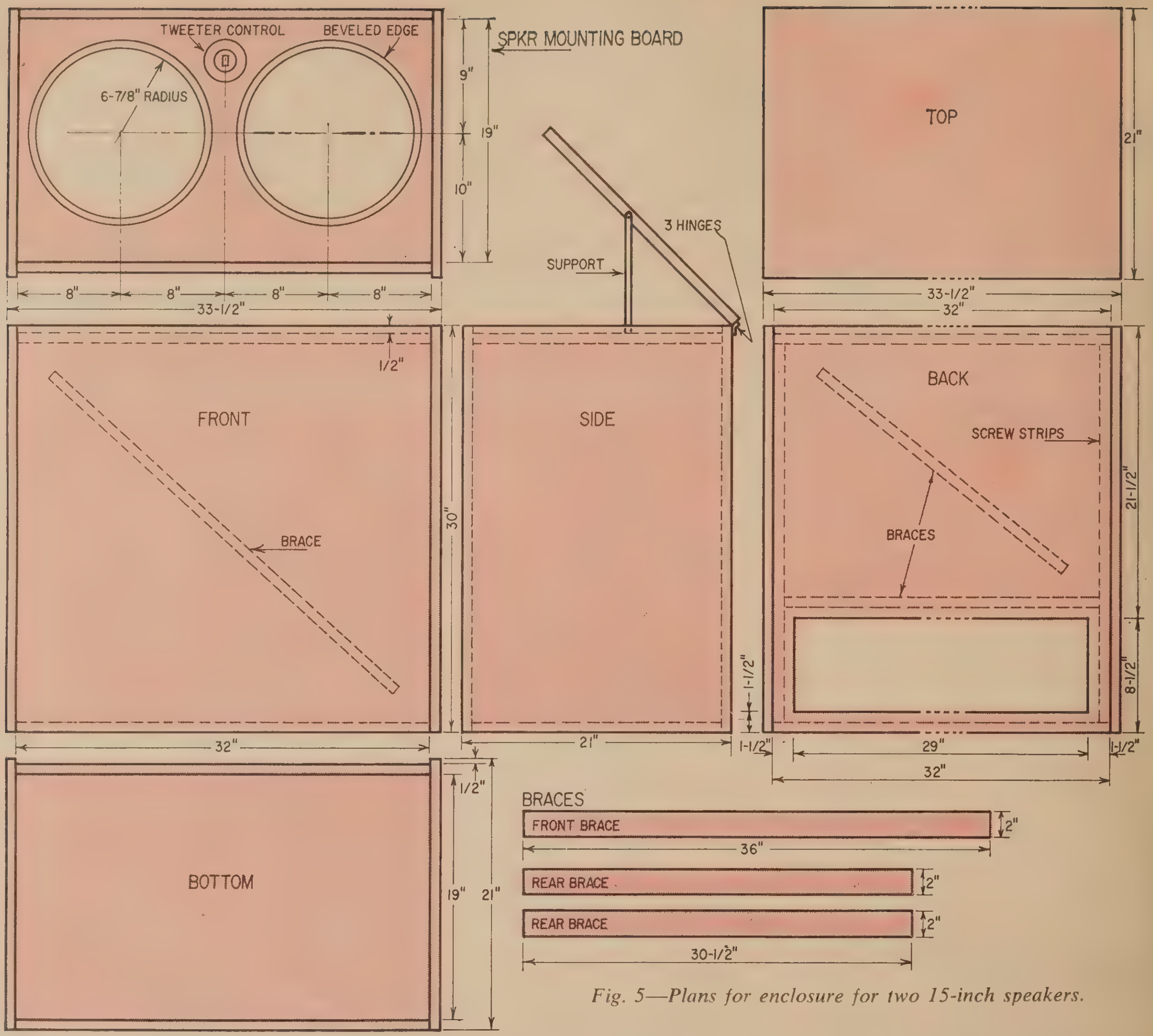

TWEETER CONTROL
BEVELED EDGE
6-7/8" RADIUS
SPKR MOUNTING BOARD
9"
19"
10"
8"
8"
8"
8"
33-1/2"
SUPPORT
3 HINGES
TOP
21"
33-1/2"
32"
1/2"
FRONT
BRACE
30"
SIDE
BACK
SCREW STRIPS
BRACES
21-1/2"
8-1/2"
1-1/2"
32"
21"
1-1/2"
29"
1-1/2"
32"
1/2"
BOTTOM
19"
21"
BRACES
FRONT BRACE
2"
36"
REAR BRACE
2"
REAR BRACE
2"
30-1/2"

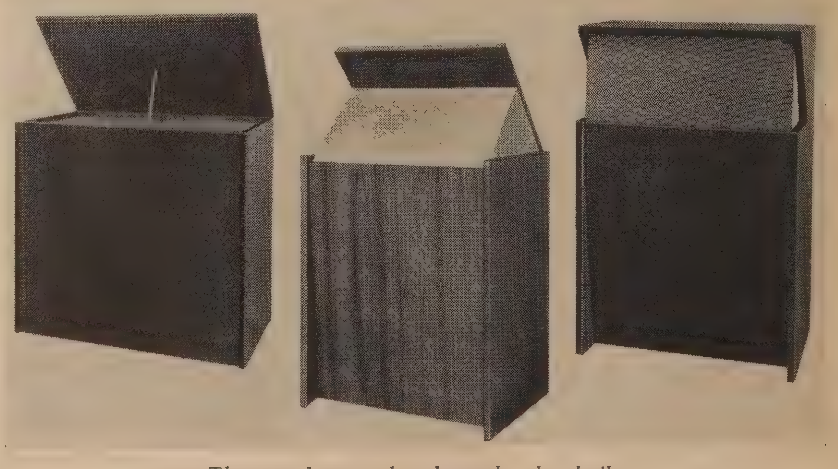
Fig. 5—Plans for enclosure for two 15-inch speakers.

For my personal use I wanted the ultimate in sound without resorting to wall-mounted speakers, as I live in an apartment. To get the most out of whatever is on records, tape, tuner, television or an electronic organ, I have built two 10-cubic-foot cabinets, each containing two 15-inch speakers—one a full-range and the other a coaxial. Details are shown in Fig. 5.

Use the same general assembly instructions as described for the 8-inch speaker cabinet. Do not leave out any of the three braces. Use all eight mounting holes when securing each speaker. Should you use a single 15-inch speaker instead of two, mount it in the center of the speaker mounting board and cut the port area in half by halving the width of the port. Cover and trim the top of the speaker mounting board with grille cloth and trim to suit your taste.

A ¼ inch brass rod makes an attractive support for the reflector or top. Drill a ¼-inch hole about a ¼-inch deep into the top of the speaker mounting board and the same in the top board at a 45° angle. Cover both holes with brass washers. Cement the top washer to the top board. Refer to your local lumber dealer to determine the choice of woods and finishes available.

This speaker-cabinet combination has more feeling of presence than any other types of combinations I have listened to. END



Three enclosures that the author has built.

By CARL DAVID TODD*

Power dissipation in resistors or transistors

Simple chart saves calculations

A VERY SIMPLE CHART CAN BE USED TO compute the power dissipation in a resistor or transistor. Once the power dissipation is known, the voltage limit for any given current can be found or the maximum permissible current for a specified voltage can be computed.

For example, if we know that a transistor's collector voltage is 2 when collector current is 10 ma, we can use the chart to compute collector power dissipated. We enter the chart from the right along the 10-ma current line and proceed until we intersect the vertical line representing 2 volts. Since they intersect on the 20 mw line, we know that power dissipation is 20 mw.

There are other ways to use the chart too. Let's assume that the maximum allowable collector power dissipation is 20 mw and a collector voltage of 2 volts is to be applied. We need to know the maximum collector current which may flow without exceeding the maximum power dissipation limit. We enter the chart from the bottom along the 2-volt line, and proceed to the 20-mw line. Now, by observing the current line passing through the point of intersection of the voltage and power lines, we find the current limit is 10 ma.

In a similar manner, if the power dissipation and the current are known, we can find the maximum voltage which may be applied without exceeding the power dissipation limit. Thus, if any two of the values of voltage, current and power are known or specified, the third may be found by using the chart.

To cover the desired range of currents, a double scale is used. The main scale runs from 1 to 100 ma. The secondary scale runs from 100 ma to 10 amperes and the values are enclosed in parentheses. The power scale also has two ranges: one from 100 μw to 10 watts and the other from 10 mw to 1,000 watts. Note that the values for the latter scale are enclosed in parentheses and are used with the secondary scale marked in the same manner.

While the chart is marked only in terms of current, voltage and power, it may also be used for multiplying or dividing any two numbers. For example, the chart may be used for computing resistance, voltage and current. The current scale is retained, but the power scale is replaced by a voltage scale, so the line representing 1 mw now represents 1 mv and the line representing 1 watt now represents 1 volt. The old voltage scale becomes the resistance scale with 1 volt replaced by 1 ohm, etc. Again, if any two variables are known or specified, the third one may be found by using the chart.

Though simply constructed, the chart is a useful tool for the circuit designer or technician. It is not as accurate a job as a slide rule, but often is just as adequate. The chance of a misplaced decimal point is considerably reduced, too. END

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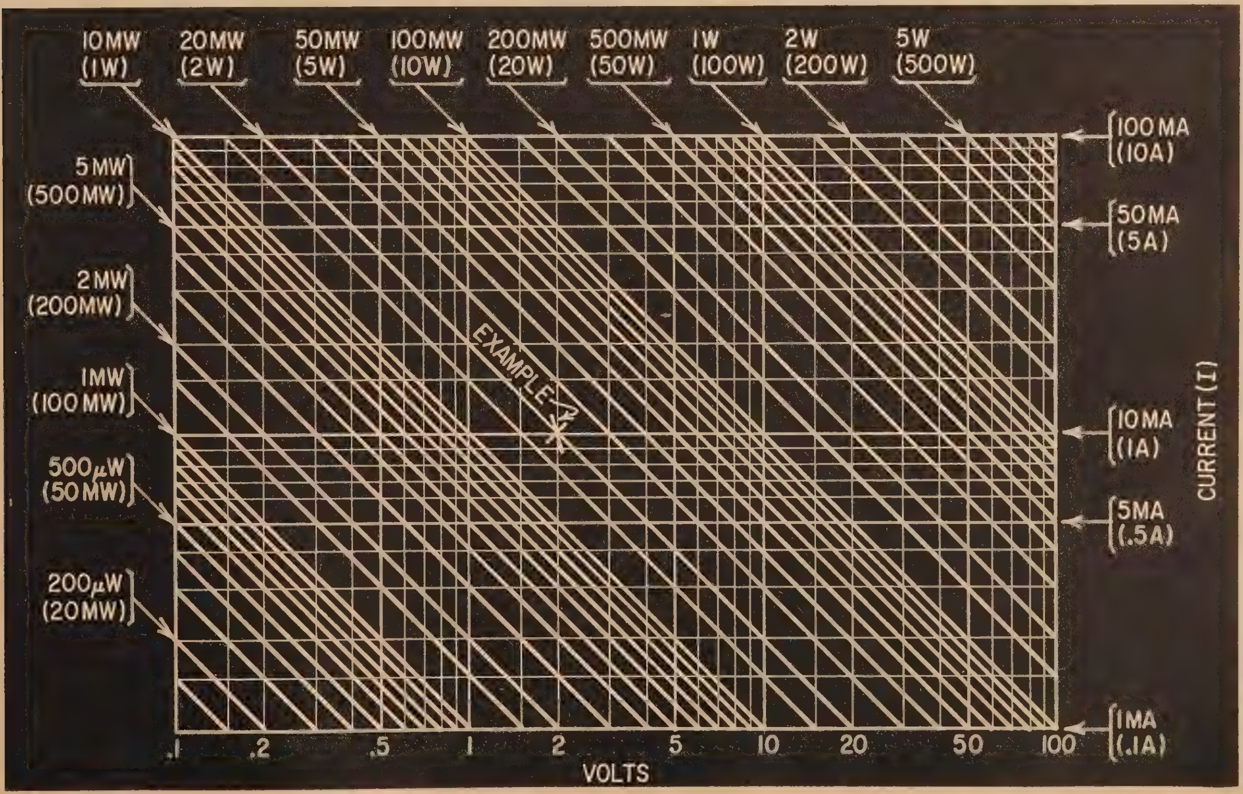
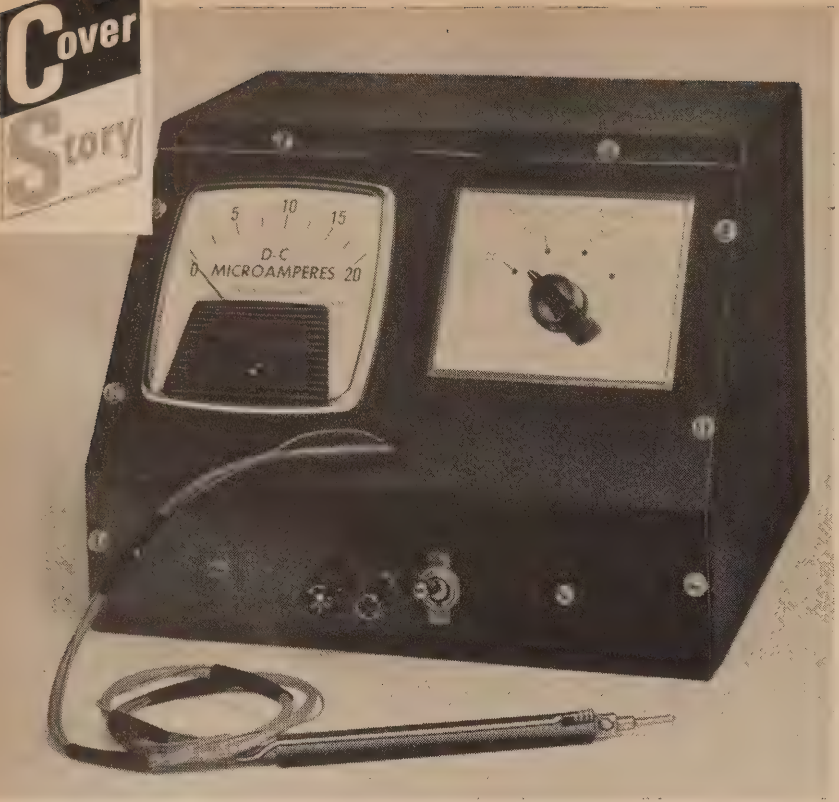
*Chief engineer, Hughes Aircraft Co.



Cover Story


5
10
15
20
0
D-C
MICROAMPERES

The meter. Binding post between fuseholder and switch is for ground lead, connected to one side of capacitor under test.

direct reading capacitance meter

measures from 1 pf to .02 μf

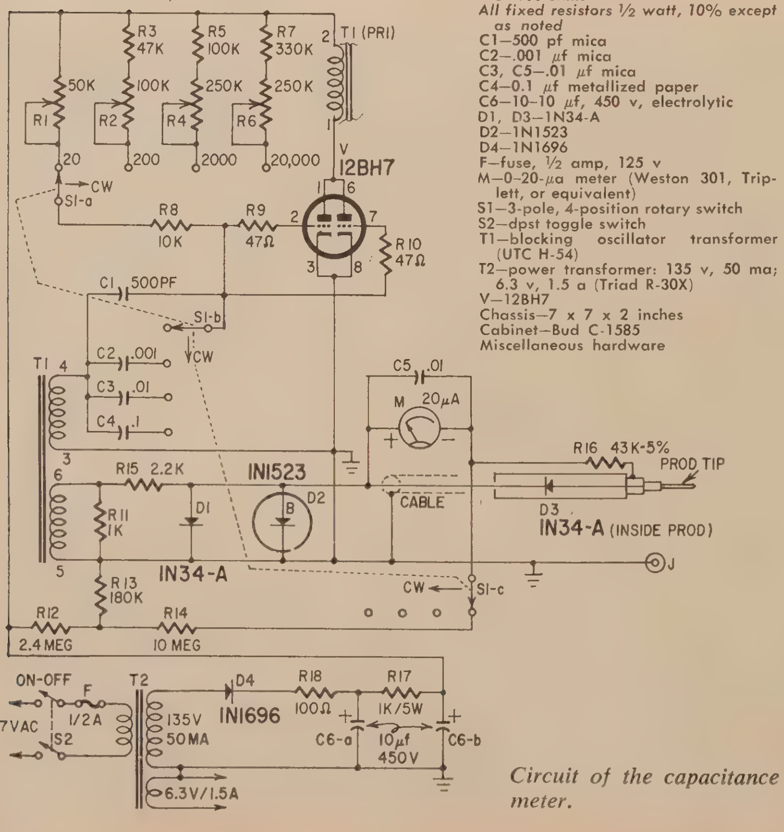
By R. L. WATTERS*

HERE IS A DIRECT-READING CAPACITANCE meter with an accuracy of ±5% and four full-scale ranges from 20 to 20,000 pf (.02 μf). It will also solve the problem of trying to read capacitor color codes. A leakage of 43,000 ohms reduces the meter reading to about half the correct value, while a leakage resistance of 430,000 ohms reduces the reading only about 10%.

The principle is simple. The capacitor to be measured is charged with a pulse from the blocking oscillator and then allowed to discharge through the 20-μa meter. If the discharge is essentially complete before the next pulse, the average current is a direct indication of the value of the capacitor. (The average current is equal to the product of the peak voltage across the capacitor, its capacitance and the repetition rate.) The return path from the probe through R16 and the meter is connected to the coax center conductor. This reduces the zero offset due mainly to current that would otherwise be flowing in the meter during the charging pulse.

The layout of parts is not critical and an example can be seen in the photographs. The chassis is 7 x 7 x 2 inches and the cabinet is a Bud C-1585. Some changes have been made in the instrument shown here. For instance, the unused seven-pin socket was for an 0B2 regulator tube which was removed when the 1N1523 Zener diode was added. The 20-pf range zeroing resistors (R12, R13, R14) were not needed in this model and have been removed. S1-c is used only on the 20-pf range. Its purpose is to switch in R12, R13 and R14 to zero the meter on this range. Since there are bound to be slight differences in each instrument, the 180,000-ohm resistor in this part of the circuit prob-

R1—pot, 50,000 ohms, linear
R2—pot, 100,000 ohms, linear
R3—47,000 ohms
R4, R6—pot, 250,000 ohms, linear
R5—100,000 ohms
R7—330,000 ohms
R8—10,000 ohms
R9, R10—47 ohms
R11—1,000 ohms
R12—2.4 megohms (see text)
R13—180,000 ohms (see text)
R14—10 megohms (see text)
R15—2,200 ohms
R16—43,000 ohms, 5%
R17—1,000 ohms, 5 watts
R18—100 ohms
All fixed resistors ½ watt, 10% except as noted
C1—500 pf mica
C2—.001 μf mica
C3, C5—.01 μf mica
C4—0.1 μf metallized paper
C6—10-10 μf, 450 v, electrolytic
D1, D3—1N34-A
D2—1N1523
D4—1N1696
F—fuse, ½ amp, 125 v
M—0-20-μa meter (Weston 301, Triplett, or equivalent)
S1—3-pole, 4-position rotary switch
S2—dpst toggle switch
T1—blocking oscillator transformer (UTC H-54)
T2—power transformer: 135 v, 50 ma; 6.3 v, 1.5 a (Triad R-30X)
V—12BH7
Chassis—7 x 7 x 2 inches
Cabinet—Bud C-1585
Miscellaneous hardware


R3
47K
R5
100K
R7
330K
2
T1 (PRI)
50K
100K
250K
250K
R1
R2
R4
R6
1
20
200
2000
20,000
V
12BH7
CW
S1-a
R8
10K
R9
47Ω
2
1
6
7
3
8
R10
47Ω
C1
500PF
S1-b
CW
T1
4
C2
.001
C3
.01
C4
.1
C5
.01
M
20μA
+
−
3
6
R15 2.2K
1N1523
R16 43K-5%
PROD TIP
CABLE
D2
B
R11
1K
D1
D3
1N34-A (INSIDE PROD)
5
R13
180K
1N34-A
J
CW
S1-c
R12
2.4 MEG
R14
10 MEG
ON-OFF
F
T2
D4
R18
R17
117VAC
1/2A
S2
135V
50MA
1N1696
100Ω
1K/5W
C6-a
10μf
450V
C6-b
6.3V/1.5A

Circuit of the capacitance meter.

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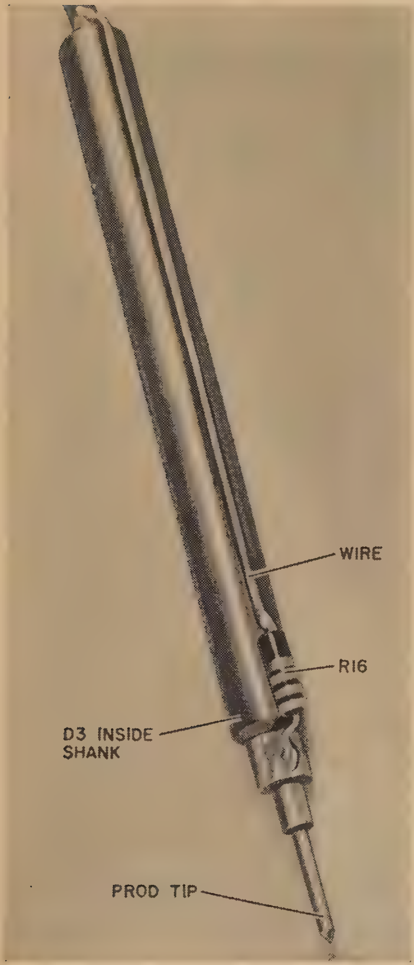
*General Electric Research Laboratory, Schenectady, N. Y.

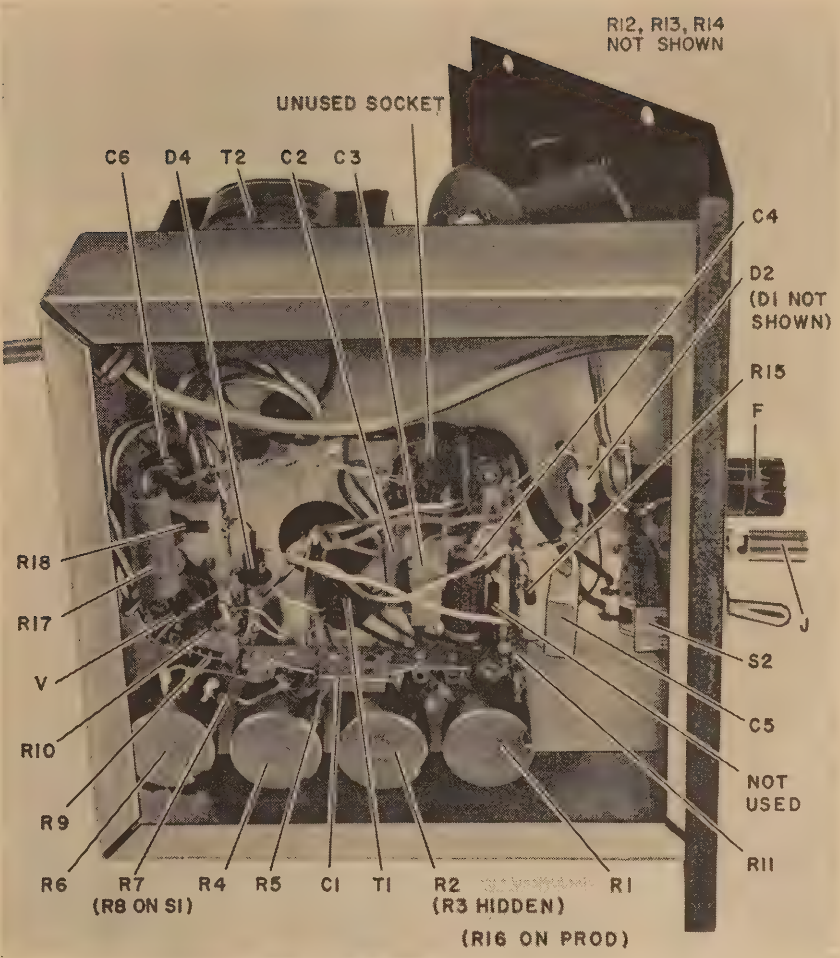

WIRE
R16
D3 INSIDE SHANK
PROD TIP

Details of test prod assembly.

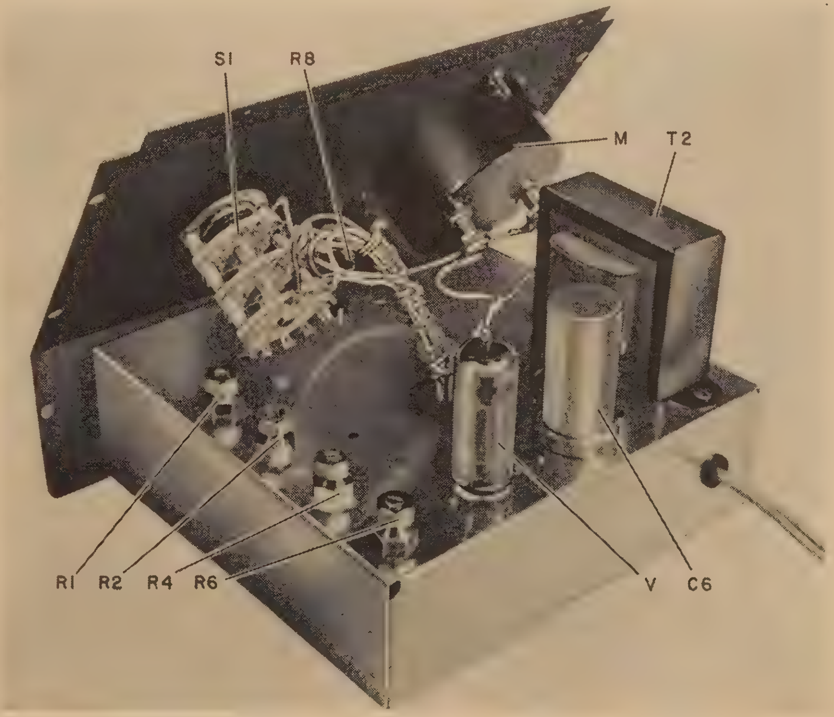
ably will need adjustment. (As in this model, the network may not be needed at all.)

The 1N34-A diode is inside the probe with about ⅛ inch of wire between the diode and the end of the probe. The coax comes within ⅛ inch of the other side of the diode. The bakelite handle was slotted (not all the way through) to hold the dc return wire. A metal collar, held with a setscrew, fits around the coax where it enters the probe. This prevents the coax from twisting inside the probe and breaking the connections. The coax is Belden 8411 microphone cable about 2½ feet long.

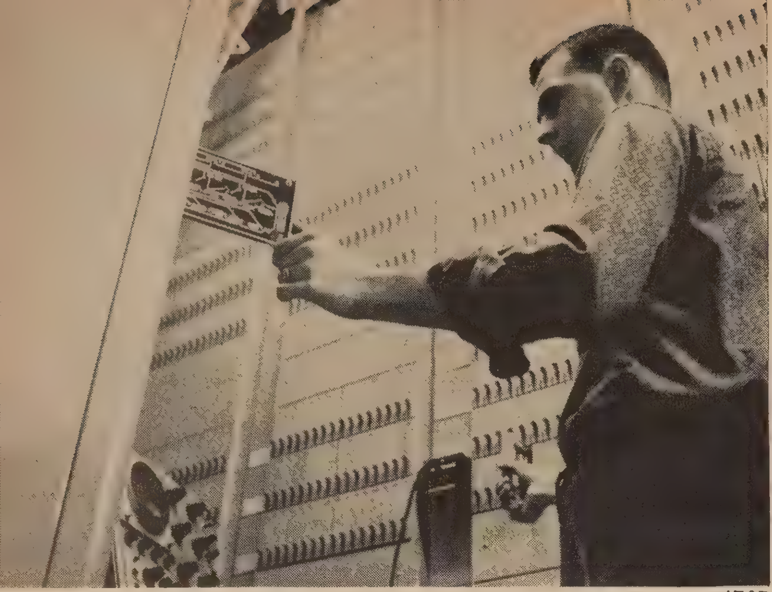
After construction, calibrate the instrument. Connect, in turn, between probe and ground four 1% capacitors of 20, 200, 2,000 and 20,000 pf. Select the proper capacitance range and adjust the meter to full scale with the calibration pots R1, R2, R4 and R6. On the 20-pf range, adjust the 180,000-ohm resistor (R13) so that the meter reads zero when the probe is held away from all objects. Since this zero adjustment and the full scale adjustment depend on each other, repeat each adjustment a few times to arrive at the final and proper settings. END


R12, R13, R14 NOT SHOWN
UNUSED SOCKET
C6
D4
T2
C2
C3
C4
D2 (D1 NOT SHOWN)
R15
F
J
S2
C5
NOT USED
R11
R18
R17
V
R10
R9
R6
R7 (R8 ON S1)
R4
R5
C1
T1
R2 (R3 HIDDEN)
R1
(R16 ON PROD)

Plenty of room underneath allowed for experimenting. Instrument could be built on smaller chassis.


S1
R8
M
T2
R1
R2
R4
R6
V
C6

View from behind. Layout used in original is optional.



AT&T

TASI terminal equipment uses 2,500 printed circuit cards.

more signals—less space

By JORDAN McQUAY

RACEP and TASI — two techniques for getting more communications over fewer channels

OUR COMMUNICATIONS BANDS ARE DAILY becoming more crowded. At the same time, the approaching sunspot minimum is shrinking the communications spectrum. Various persons and organizations have been spurred to search for entirely new techniques of boosting traffic capacity—particularly for voice communications. These have varied from ambitious attempts of hopeful hams to the elaborately engineered experiments of our biggest communications companies.

At least two of several recent developments are really very ingenious, and may become important in the future.

One is RACEP—*R*andom *A*ccess and *C*orrelation for *E*xtended *P*erformance. It was originated by the Martin Co.'s Orlando (Fla.) Div. to handle hundreds of two-way pulse-modulated radiophone signals over a single wideband vhf channel or carrier.

The other is TASI—*T*ime *A*ssignment *S*peech *I*nterpolation. It was developed by American Telephone & Telegraph Co.[1] for high-speed electronic switching between a fixed number of one-way voice-frequency channels on long-distance submarine cable systems.

The two systems have one thing in common—the maximum use of idle spectrum space within the band being used, or of breaks and pauses in normal voice conversations and the idle time between actual calls or data messages. Either could be adapted—with suitable components and circuitry—to *any* limited part of the frequency spectrum, and could be used for either radio or wire (cable) communication as well.

RACEP—how it works

This system can be compared to a combination lock in which only a receiver set to the combination of the transmitter can receive the transmitted signal, though dozens of other signals are being transmitted at the same time on the same (broad) frequency.

A complete RACEP system of the present type consists of a maximum of about 700 stations, each of which is a portable vhf transceiver. They are identical, weigh about 35 lbs each, have a telephone type headset, vertical antenna and a 24-volt dc power supply. The transceiver requires about 300 watts of power.

The transceivers have no tuning controls on the simple operating panel. The rf stages of both transmitting and receiving circuits are preset to the system's fixed vhf carrier in the range of 140-144 mc. A station selector on the operating panel sets the equipment to the three-part *identity code* of the desired station.

The input voice or data signals are first sampled at about 8 kc by the *signal encoder*. It produces 1-μsec pulses every

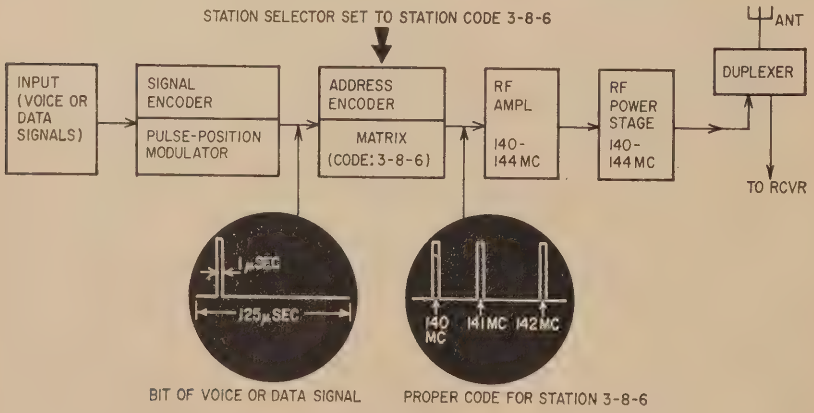

STATION SELECTOR SET TO STATION CODE 3-8-6
ANT
INPUT (VOICE OR DATA SIGNALS)
SIGNAL ENCODER
PULSE-POSITION MODULATOR
ADDRESS ENCODER
MATRIX (CODE: 3-8-6)
RF AMPL 140-144 MC
RF POWER STAGE 140-144 MC
DUPLEXER
TO RCVR
1 μSEC
125 μSEC
140 MC
141 MC
142 MC
BIT OF VOICE OR DATA SIGNAL
PROPER CODE FOR STATION 3-8-6

Fig. 1—Block diagram of RACEP transceiver when transmitting to station 3-8-6.

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[1] Bell Telephone Labs and Long Lines Div.

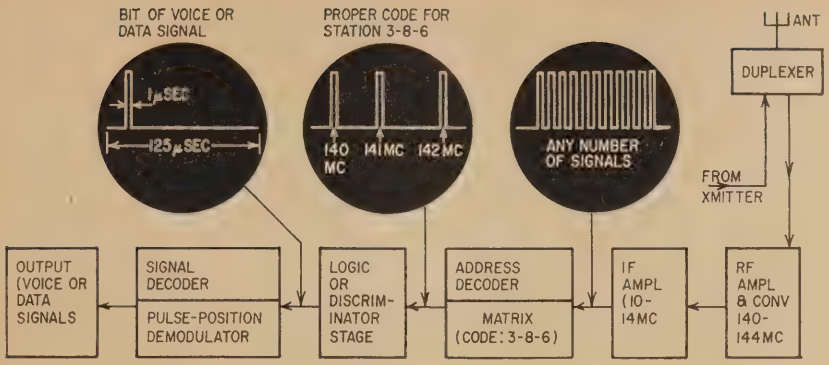


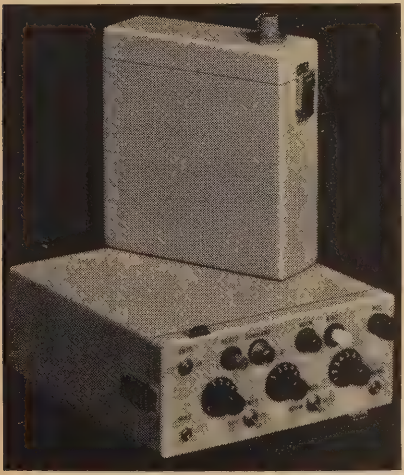
Fig. 2—Block diagram of RACEP transceiver when receiving a signal.

125 microseconds. Each sampled bit is applied to the *address encoder* to produce a code group of three subcarrier pulses, each 1-μsec in duration, but occurring at relatively different times or frequencies. A typical group would be, for example, 140.0, 141.0 and 142.0 mc. The block diagram of Fig. 1 shows the general principles of the system. The rather odd spacing of the three pulses shown is due to the *pulse position modulation system*[2] used. Instead of varying the amplitude of the pulses, modulation varies their position in the sampling.

The three-part subcarrier output of the address encoder passes through two further stages of broad-band rf amplification and then to the antenna. The RACEP system of using extremely narrow 1-μsec pulses allows many vhf signals to occupy the same common vhf carrier with only negligible interference between signals.

RACEP reception

Fig. 2 is the basic block diagram of the receiving circuit of the transceiver. The receiving circuit accepts all signals in the 140-144-mc range. This mass confusion of hundreds of pulsed signals goes through an rf amplifier, is converted to a 10-14-mc i.f., and fed to the *address decoder*. It blocks or filters out all pulsed vhf signals except those of the correct identity code.



Martin Co.

RACEP manpack receiver–transmitter has 2-mile range, weighs less than 5 pounds.

The output of this stage thus consists of recurring groups of three subcarrier pulses. They pass through a coincidence gate, called a *logic*, or *discriminator*, stage. There, each group of three subcarrier pulses is converted into a single bit of pulse. These 1-μsec pulses, recurring every 125 μsecs, are fed to a signal decoder or nonsynchronous pulse position demodulator, which regenerates the original voice or data signal.

A command override feature is also incorporated in the receiving circuits of all RACEP transceivers. This alerts *all* stations within range, and permits them to accept signals immediately from the overriding transceiver. This is done by using a special identity code acceptable to the receiving circuits of all transceivers in the system.

Although originally designed by the Martin Marietta Corp. as a radiotelephone system with a maximum of 700 stations, current developments promise an increase of several hundred additional stations to any RACEP system—with all stations operating simultaneously on the same wide-band vhf carrier.

The TASI technique

This system (*T*ime *A*ssignment *S*peech *I*nterpolation) was designed to increase the traffic-handling capacity of submarine telephone cables. TASI makes it possible to handle a maximum of 72 calls over 36 channels.

In a normal two-way phone conversation—even over an expensive trans-Atlantic cable—each person, on the average, speaks only half the time, and even while he is speaking there are gaps and pauses in his speech. If the two directions of transmission are separated, each path is idle more than half the time. If conversations were interlaced to take advantage of these gaps, you could get at least twice as many conversations per channel.

In practice, more than two channels are needed for the system to work—two talkers would frequently be speaking at the same time—but with as many as 36 channels, the probability is that there will always be room for 72 conversations.

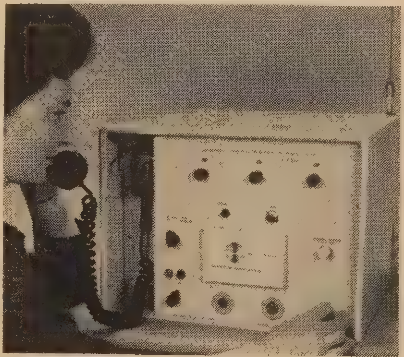
TASI control

Brains of the TASI system is the *control unit* which monitors all 72 input circuits, synchronizes sampling of "active" signals, controls high-speed switching between "active" signals and the available transmission channels, and supplies the synchronizing tone to control switching elements at the distant receiving terminal. When a signal appears at an input circuit, the control unit goes into action automatically. It selects any unoccupied transmission channel and feeds it a *connecting tone*—a 10-millisecond burst of four audio frequencies. This tone identifies the original circuit of the "active" input signal about to be connected to the channel. Then the control unit energizes input and gate switches, connecting the input signal to the channel.

If the signal stops briefly (becomes "inactive") and the transmission channel is needed for other "active" input signals, the control unit automatically disconnects the "inactive" signal, feeds the transmission channel a different 10-millisecond burst to identify a different input, and switches another active signal directly to that channel.

During a 5-minute voice conversation, one input signal may be switched several dozen times to a large number of transmission channels—all without the knowledge of the original speaker or distant listener.

While the control unit monitors each of the input signal detectors to determine the identity and status (active or inactive) of each input circuit, it also accepts signals from each of the input signal samplers and stores them as a



Martin Co.

RACEP transceiver in use.

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[2] "PPM—New Technique", RADIO-CRAFT, Feb. 1946

digital code. Whenever there are more active signals than available transmission channels, these excessive active signals are "stacked up" in the data-storage facility of the control unit. Then, as channels become available, the stored input signals are connected to the available channels in proper sequence.

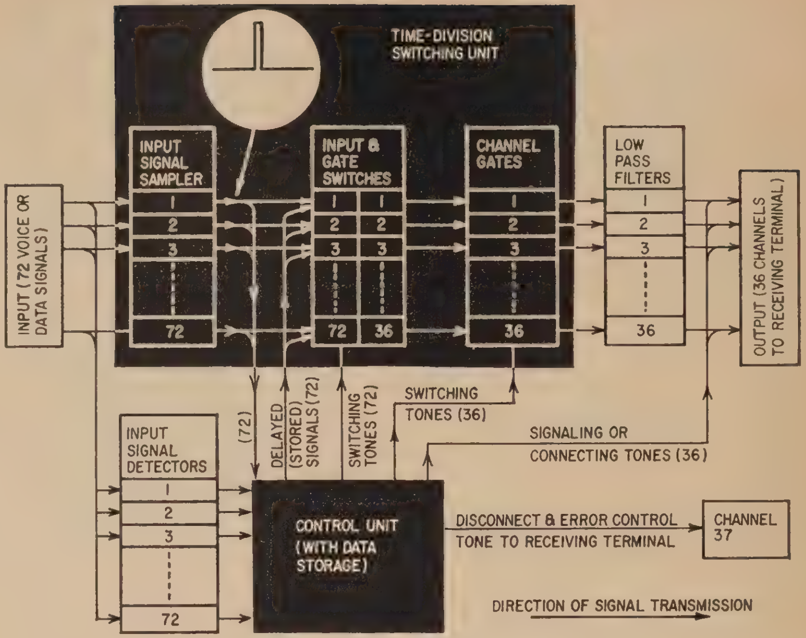

TIME-DIVISION SWITCHING UNIT
INPUT SIGNAL SAMPLER
1
2
3
72
INPUT & GATE SWITCHES
1 1
2 2
3 3
72 36
CHANNEL GATES
1
2
3
36
LOW PASS FILTERS
1
2
3
36
INPUT (72 VOICE OR DATA SIGNALS)
OUTPUT (36 CHANNELS TO RECEIVING TERMINAL)
(72)
DELAYED (STORED) SIGNALS (72)
SWITCHING TONES (72)
SWITCHING TONES (36)
SIGNALING OR CONNECTING TONES (36)
INPUT SIGNAL DETECTORS
1
2
3
72
CONTROL UNIT (WITH DATA STORAGE)
DISCONNECT & ERROR CONTROL TONE TO RECEIVING TERMINAL
CHANNEL 37
DIRECTION OF SIGNAL TRANSMISSION

Fig. 3—Transmitting terminal for TASI system.

TASI transmission

A TASI transmitting terminal (Fig. 3) feeds 36 traffic channels and 1 control channel—all one-way facilities for communicating with the distant receiving terminal. The principal components are a parallel array of 72 *input signal detectors*, the *control unit* with provision for data storage, and a *time-division switching unit* that has high-speed switching and signaling elements. The input signal detectors indicate whether an active input signal is present or not. Each dissector is a high-gain amplifier, so adjusted that it operates only above a critical threshold level.

When signals are fed to the control unit, the threshold level is exceeded. The first part of the *time-division switching unit* is a parallel array of 72 disintegrators, called *input signal samplers*. Each "active" input signal is sampled at about 8 kc, producing a 2-μsec pulse. Sampling for such a short interval permits sampling all 72 input circuits without overlapping. The pulses that result from this collective sampling are switched electronically, during the sampling intervals, to an available and unoccupied channel. The input and gate switches are operated by tone signals originated by the *control unit*.

Thus each traffic channel receives a recurring series of digital pulses from any one input at a time, the exact source of any one of the 72 possible inputs being determined by the time-division switching unit. After each of the 36 channel gates, the train of digital pulses moves through a low-pass filter and is reconverted into analog (voice) signals.

TASI reception

Preceding any traffic reaching the receiving terminal, the connecting tone—a brief burst of four audio frequencies—comes over the channel to the receiving terminal (Fig. 4). This signaling or connecting tone is not heard by listeners. It is blocked by a gate in the time-division switching unit. As a result, the signaling tone is applied to one of the 36 connect-tone detectors.

A control unit similar to, but simpler than, the one in the transmitting terminal monitors the outputs of all these detectors. When a signaling tone is received by one of the connect-tone detectors, the control unit of the receiving terminal opens the correct channel gate electronically, then activates the switches to connect the channel to the correct one of the 72 output circuits. The signaling or connecting tone identifies the output circuit.

An additional channel—usually called No. 37 and not used for traffic transmission—carries a separate control tone, called the *disconnect and error tone*. It disconnects traffic channels from output signal circuits.

While this system could be applied to other types of circuits than submarine cables, the equipment for the ends of the transmission line is complicated and expensive. In most cases it would be more practical to install additional transmission channels. The underwater cable is the exception that makes TASI useful under present conditions. The equipment required occupies 17 rack cabinets at each terminal of a two-way system. A complete station installation has about 10,000 transistors of several types and more than 100,000 semiconductors and other parts and components. About 2,500 printed circuits are required at each terminal. END

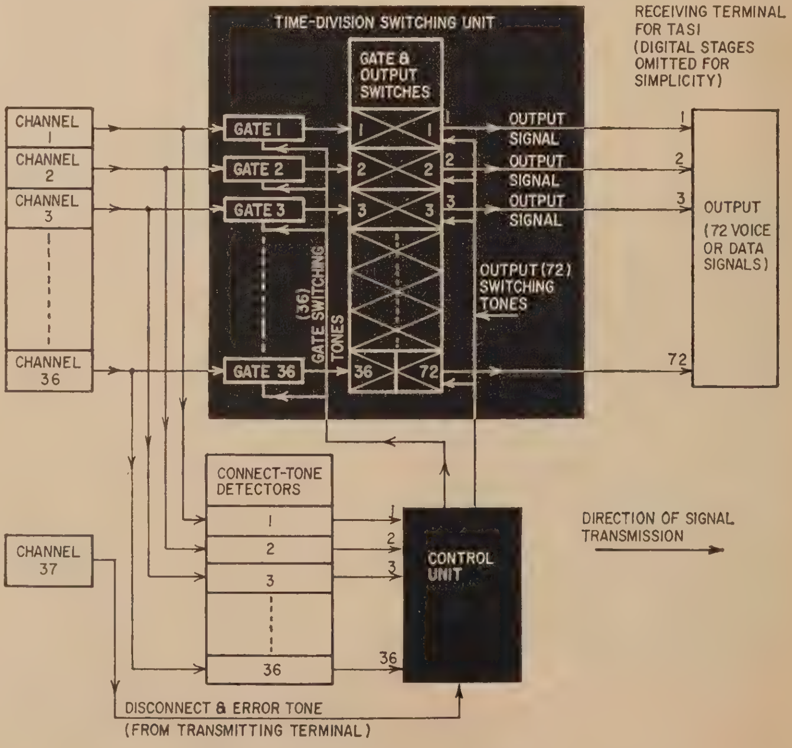

TIME-DIVISION SWITCHING UNIT
RECEIVING TERMINAL FOR TASI (DIGITAL STAGES OMITTED FOR SIMPLICITY)
GATE & OUTPUT SWITCHES
CHANNEL 1
CHANNEL 2
CHANNEL 3
CHANNEL 36
GATE 1
GATE 2
GATE 3
GATE 36
1 1
2 2
3 3
36 72
OUTPUT SIGNAL
OUTPUT SIGNAL
OUTPUT SIGNAL
OUTPUT (72) SWITCHING TONES
(36) GATE SWITCHING TONES
1
2
3
72
OUTPUT (72 VOICE OR DATA SIGNALS)
CONNECT-TONE DETECTORS
1
2
3
36
CONTROL UNIT
CHANNEL 37
DIRECTION OF SIGNAL TRANSMISSION
DISCONNECT & ERROR TONE (FROM TRANSMITTING TERMINAL)

Fig. 4—Receiving terminal of TASI system.

MYSTICISM IN OUTPUT MATCHING

What we learned in the school books is true, but not necessarily relevant.

By HERBERT A. RAVENSWOOD

IN THE ARTICLE "TAKING THE MYSTICISM Out of Matching," July, 1961, we considered "input" matching: from some kind of transducer—microphone, pickup or tape head—to a tube or transistor input, or from a preamp output to a main amp *input*. In all cases, we were mostly concerned with adequate voltage or current level and freedom from nonlinear or frequency-response distortion.

Output matching is often concerned with maximum power transfer. Thus, at first sight, it would seem to call for the theoretical or schoolbook ideal: load impedance equal to source impedance. To get this straight, the first thing we have to do is distinguish between maximum power transfer and maximum *efficiency* of power transfer. They are not the same thing. Let's illustrate.

Assume we have a supply, from a battery, generator or alternator—it doesn't matter. It gives 110 volts open-circuit and has an internal resistance of 5 ohms. According to the ideal matching theory, the load should also be 5 ohms, making 10 ohms total. The current will be $\frac{110}{10}$ = 11 amps. The power transfer will be 55 volts (the voltage across the load) × 11 amps, or 605 watts.

If we use a 6-ohm load, the current will be $\frac{110}{11}$ = 10 amps, the load voltage 60, and the power transfer 600 watts. With a 4-ohm load, current will be $\frac{110}{9}$ = 12.2 amps, load voltage 48.9 and power transfer 597.5 watts. This proves that a 5-ohm load yields maximum power transfer — 605 watts.

But to get the power into the load, additional power is lost in the battery, generator or alternator. With a 5-ohm load, for 605 watts output, 605 watts is lost internally; an efficiency of 50%. With a 6-ohm load, the internal voltage drop is 50, the current 10 amps, the internal power loss 500 watts. Of a total of 1,100 watts (instead of 1,210 watts with a 5-ohm load), 600 reach the 6-ohm load; an efficiency of 54.5%.

With a 4-ohm load, for 597.5 watts output, the internal volt drop is 61.1, the current 12.2 amps, the internal power loss 747 watts. Of a total of 1,344.5 watts, 597.5 reach the 4-ohm load; an efficiency of 44.4%.

Now let's figure out that happens with a 50-ohm load: total resistance 55 ohms, current 2 amps; voltage across load, 100, internal drop, 10 volts; power in load, 200 watts; internal, loss 20 watts; total power 220 watts; efficiency 91%.

So, by being content with about one-third of the *maximum* power, the efficiency rises from 50% to over 90%. Regardless of how you are billed for it, what has to be bought is the total power, not the power output. This is another good reason (fire hazard is the first) why it's not good to load your supply so it drops from 110 volts to 55!

Why do we match?

We worked through that just to show that the academic ideal doesn't often work out for practical purposes (even in power engineering). But now to audio and kindred subjects: this introduces many more factors. First we'll list them, then explain them.

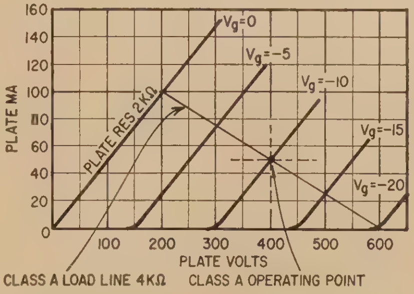


Fig. 1—Class-A operation, ideal triode.

In the simple power case, we had two possible objectives: matching for maximum power, or for maximum power-transfer efficiency. In audio outputs we have at least four possible objectives, any one of which may be most important in individual cases, with the others having either subsidiary importance or being unimportant. These four are:

1. Matching for maximum power output within the tube or transistor power dissipation limits;
2. Matching for minimum distortion of the output power, compared to the input waveform;
3. Matching for maximum gain: the most power output for a given input signal voltage (for tubes) or current (for transistors);
4. Matching for correct impedance or damping factor relationship.

When we've digested these basic different objectives, the matter can be approached from two viewpoints: that of the tube or transistor, and that of the load. This has caused much extra confusion since feedback became almost universal.

Finally, there is the complication of multiple operation. So far, we have been concerned with only one source—a tube or transistor output stage—feeding one load; matters are complicated when either is shared. Such sharing may be between either the source (two or more tubes, or their screens as well as their plates) or the load (feeding more than one loudspeaker, possibly at different power levels) or sometimes both.

Small wonder the uninitiated—and some engineers—get confused about matching. To try and simplify matters, let's take up each of the points, one at a time.

Maximum power

This is the case where we have one or two output tubes or transistors, with a maximum dissipation before they "blow," and we want to get the maximum audio power output from them. In this problem we are not primarily concerned with grid input volts or base input current. Whatever is needed we can get, somehow; but we mustn't exceed the tube or transistor ratings.

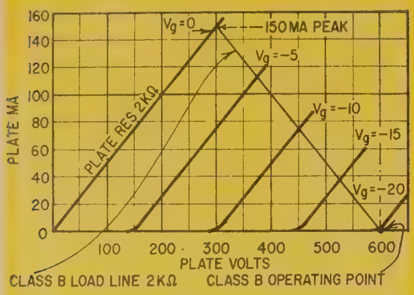


Fig. 2—Fig. 1 Triode in class B.

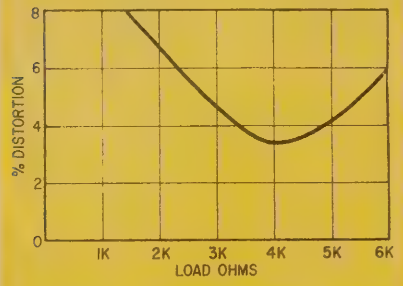


Fig. 3—Distortion–load curves like this can be quite meaningless.

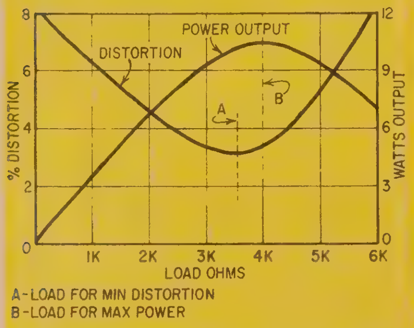


Fig. 4—This is a useful type of curve.

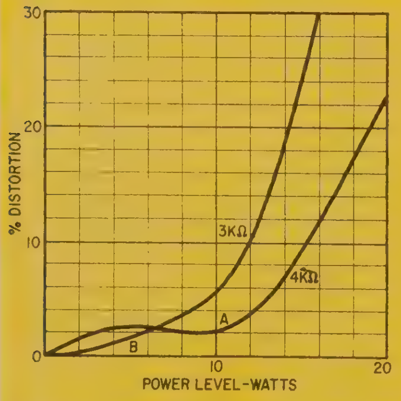


Fig. 5—Distortion figures differ with small changes in load value. Note different curves for 3,000 and 4,000 ohms.

Assume an "ideal" triode tube (one with perfect curves, Fig. 1) is operated class-A, with 400 volts at 50 ma static plate current. This represents its maximum dissipation of 20 watts. It has a plate resistance of 2,000 ohms. Optimum load—the one for maximum relatively undistorted power—will be 4,000 ohms. The peak audio voltage and current in this load will be 200 volts 50 ma, a peak power of 10 watts, or an rms rating of 5 watts. This is 25% efficiency.

We can improve this by what is called class-B working, or a part-way measure called class AB. We will assume a perfect class B. The plate voltage is now made 600, operating current (theoretically) zero (Fig. 2). Each of two tubes delivers power for half the output waveform, with a peak value of 300 volts 150 ma, using a load equal to the plate resistance of 2,000 ohms. This is a peak audio power of 45 watts, with a peak dissipation of 45 watts.

On a sine wave, the average dissipation during each half-cycle, in this mode of operation, is 77.5% of maximum; over the full cycle (the other half is inactive) it is 38.75%. So the average dissipation per tube, at maximum power, is 17.4 watts—well within the rated 20. The audio power from two tubes, rms rating, is 22.5 watts, as against 10 watts from two tubes working class A.

We'll come back to what impedances mean in the output transformer for these two cases later on. We could pursue this matter of maximum power output within maximum power dissipation through pentodes, transistors and other devices, but this illustrates a couple of typical relationships.

Pentode and transistor matching does not introduce an "ideal" relationship between source and load impedance, for the simple reason that the theoretical ideal plate or collector resistance is infinity, while the optimum load resistance is always finite and is governed by things other than its relation to a theoretically infinite quantity.

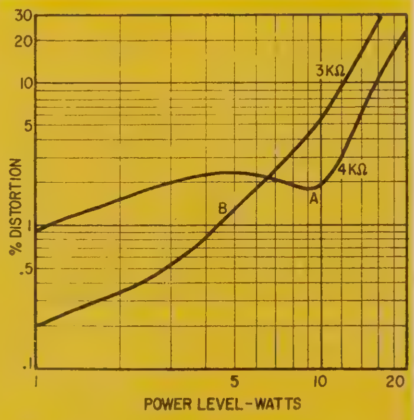


Fig. 6—A more truthful curve is one plotted on log paper instead of linear. This is a replot of Fig. 5.

In a theoretically ideal pentode, the plate current–voltage curves would be horizontal lines above the "knee," signifying infinite plate resistance. The choice of load resistance is determined by finding a load line that will give the biggest combination of voltage and current swing, to make audio power, without using an area of the curves that goes over the permitted dissipation for the tube(s).

Minimum distortion

When you take distortion into account, the matching problem becomes involved. A curve that plots distortion against load value (Fig. 3) is meaningless unless more details are given. At what level of power output is the curve taken? Is the power kept constant as load value is changed? Such a curve can be taken in a variety of ways; unless you know how it was taken, it is of little value to you.

One method is to set the level at each load value to represent the same power output, which should be stated. The curve may be quite different if the level is changed. Another method is to set the level at each load value to the maximum output before clipping—itself a form of distortion—commences. Information obtained from this method does not mean anything unless the curve is accompanied by a corresponding curve for power (Fig. 4).

The thing that can be misleading about any matching-for-minimum-distortion presentation is that distortion changes with level in different ways for different load values (Fig. 5). So the choice of load value depends on what you consider "minimum distortion." One value will produce minimum distortion at maximum output; another will maintain minimum distortion over a range of lower levels. These values are not usually widely different, so the distinction may be more academic than practical in most instances.

But the way you plot distortion, using log or linear scales, can make a difference to what it looks like (Fig. 6). Note that the low-level distortion now looks more important.

Why do we have these differences in distortion characteristic? It is well known that a single pentode output stage produces a distortion characteristic, as load value is changed, with a minimum value where the second harmonic disappears (Fig. 7). In a push-pull circuit, properly balanced, there is no second harmonic. But the third harmonic can have two effects; it may either "sharpen" or "round" the waveform (Fig. 8). In many push-pull circuits employing pentodes, both forms of third-harmonic distortion occur *at different levels*, feeding the same load, and there is also a fifth-harmonic component (Fig. 9).

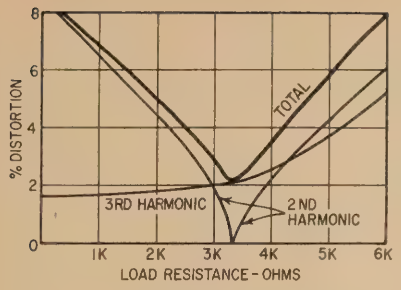
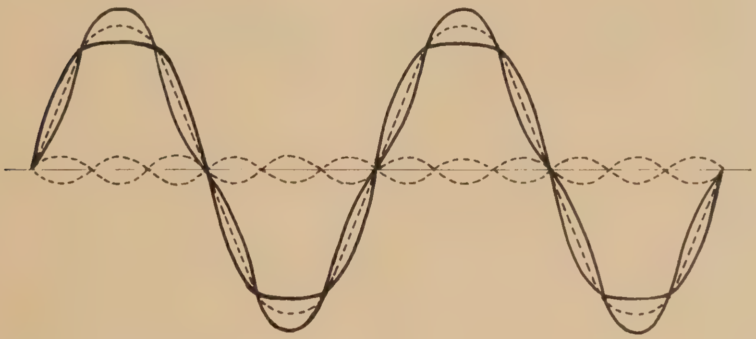


Fig. 7—How the distortion varies with load in a typical single-ended pentode.

Fig. 8—Third-harmonic distortion can have two effects on the waveform; dashed line is fundamental, solid lines show the two effects of third harmonic.



Between the variables of load value and level, distortion can change in a complicated fashion. That's assuming the load is just a simple resistance. When you include the reactance elements in loudspeaker impedances, distortion is quite unpredictable.

Maximum gain

This aspect of matching comes closest to what we learned in school. In this case, what we said earlier about somehow being able to get whatever grid volts or base current we need is not the case. An example is the one-tube amplifier used in some low-priced phonographs.

The grid swing is limited to the output from the ceramic or crystal pickup cartridge. We want the maximum output power that a single pentode stage will produce from this grid input. The load required will differ from what we had when we were matching for either maximum undistorted power or minimum distortion: It will be closer to the academic ideal than the value selected for other purposes.

Matching for this condition will not usually achieve either maximum power, for the tube or tubes are capable, or minimum distortion. But it does produce the *loudest* sound for the available grid input from the pickup cartridge. If a bigger grid swing were available, a different operating point and load resistance give us greater output power, lower distortion or both.

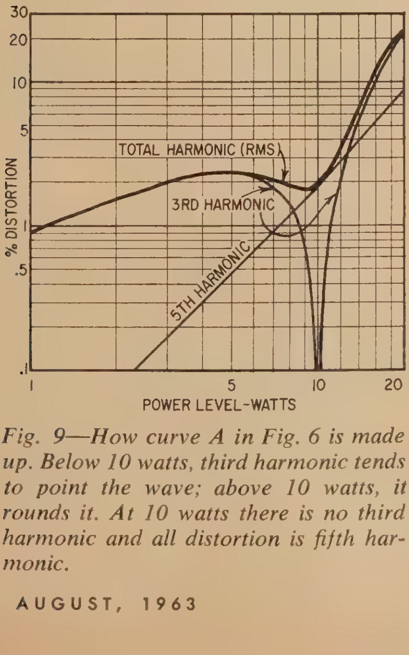
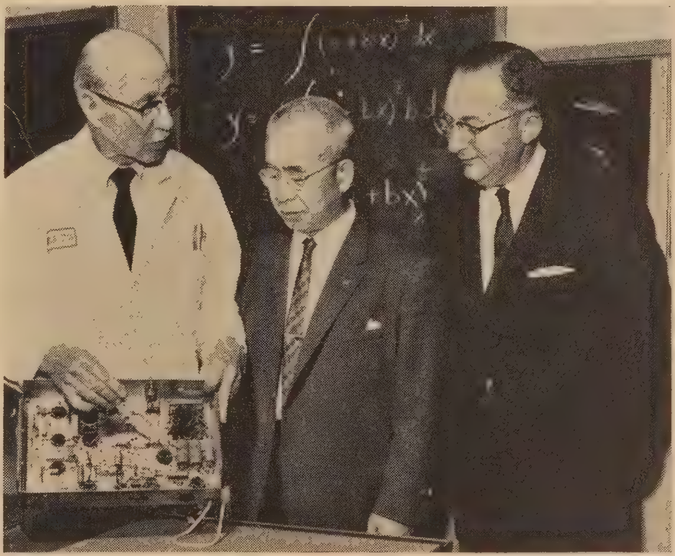


Fig. 9—How curve A in Fig. 6 is made up. Below 10 watts, third harmonic tends to point the wave; above 10 watts, it rounds it. At 10 watts there is no third harmonic and all distortion is fifth harmonic.

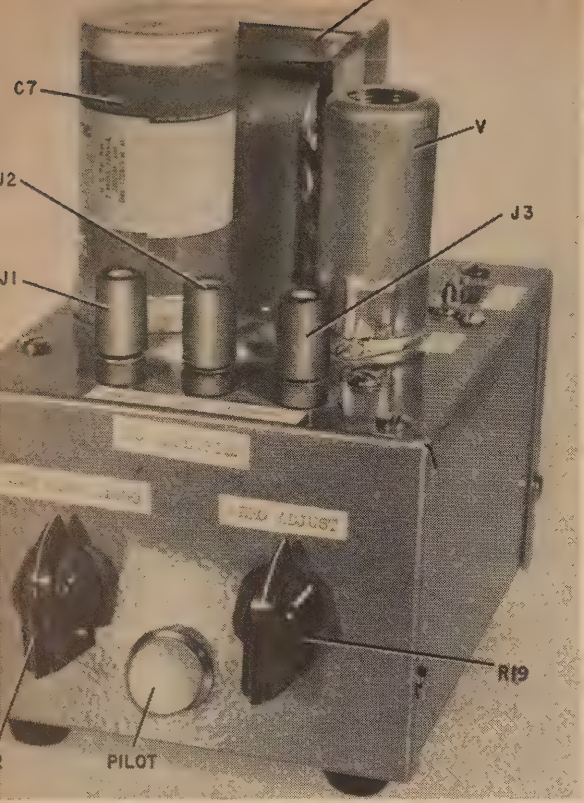
Thus we see that choice of load value in output matching has a number of different possible objectives—or combinations of them—to meet. *No single optimum load will suit all these objectives.* This has been the reason for some confusion. Different values may have been published for the same tubes, without stating for what parameters the load is optimized, or the parameters may have been stated but overlooked because the reader had the notion "optimum load" had some absolute meaning. We hope this discussion will clarify this matter, so you will no longer be looking for an absolute optimum, and will be curious enough to find out what parameters governed the choice: maximum power output, minimum distortion or maximum gain.

The fourth point we listed introduces some further aspects that are quite independent of those we have just discussed. Why is the resistance, as determined by a quantity called damping factor, at an output terminal plainly marked 16 ohms, only 0.1 ohm? How can one pair of terminals at the same time have two such different impedances? This and other questions, particularly relating to the effect of feedback on this kind of situation, and some complications that arise with different impedance loudspeakers being connected to different amplifier taps than those bearing the right "ohmage" label, are a complete story in themselves, and will be discussed in a later article. END

Japanese Industrialists Survey US Training Methods



Leaders of Japanese industry are surveying newest American training techniques in electronics, radio and television as well as mechanical engineering. Toshitane Takata, center, is the leader of a 15-man delegation visiting technical schools and business firms across the U.S. He is conferring with Emil Witke, instructor at the National Technical Schools, Los Angeles, who is demonstrating classroom equipment and with the president of the school, Dr. J. L. Rosenkrantz. The visiting group is sponsored by the Japan Productivity Center.



Chopper-Stabilized Dc Amplifier

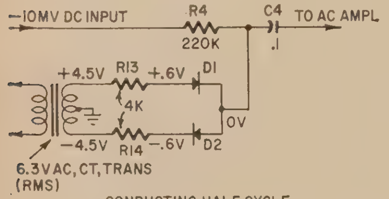
Build this no-drift dc amplifier to sensitize your vtvm. Operates with a gain of 1,000. It uses a silicon diode chopper

By **EARL T. HANSEN**

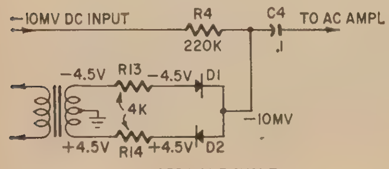
This amplifier is designed to extend the range of a dc vtvm 1,000 times—it will read millivolts instead of volts. It is free from drift and is not affected by severe overloads fed to its input.

Incorporated in the amplifier is chopper stabilization, well known in industrial electronics. Usually an expensive mechanical chopper is used. This would be highly impractical for the experimenter on a budget, so I used some inexpensive silicon diodes to make an electronic chopper at a reasonable cost.

A dc amplifier including two or more direct-coupled stages is basically unstable. Changes in heater and plate supply voltages, tube characteristics, component drift or other conditions would normally cause insignificant changes in the plate potential of a single stage. But, when these small changes are amplified by another stage, the result is instability in the form of dc drift. Unless the effects of this drift are continuously compensated for, such an amplifier is not usable.



CONDUCTING HALF CYCLE
a



CUT-OFF HALF CYCLE
b

Fig. 1—Simplified modulator circuit showing circuit operation during (a) conducting half-cycle and (b) cutoff half-cycle.

Drift can be eliminated by converting the dc to ac, amplifying with an RC-coupled ac amplifier and converting the resulting signal back to dc in a demodulator. By using a phase-sensitive demodulator, the proper polarity can be recovered and the effects of noise minimized. The amplifier described here uses a diode modulator and demodulator with a 60-cycle modulation rate.

The modulator

Fig. 1 is a simplified diagram of the modulator. Assume that diodes D1 and D2 have equal forward voltage drop (approximately 0.6 volt), that R13 equals R14 and that the transformer is exactly center-tapped. Fig. 1-a shows the voltage at each point with respect to ground, during the peak of the conducting half of the cycle. Note that the junction of the two diodes is at zero or ground potential. Therefore the input dc is dropped across R4.

Fig. 1-b shows voltages at various points during the nonconducting half of the cycle. Note that both diodes are now reversed biased and nonconducting —effectively open. Therefore, the junction is free-floating and assumes the potential of the input, —10 mv, while during the conducting half-cycle that junction point is effectively clamped to ground. As the cycle is repeated, we get an ac signal to feed to the amplifier. The phase of this ac reverses as the polarity of the dc input signal changes.

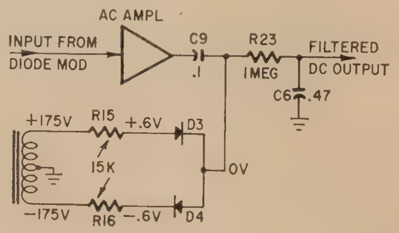


Fig. 2—Demodulator circuit. Voltages shown at peak of conducting half-cycle.

The ac signal is amplified and fed to a demodulator (Fig. 2). Since the amplifier has a gain of about 2,000, its output through C9 has a peak-to-peak value of 20 volts (Fig. 3-a). We must now recover the dc from this ac signal. If it were simply rectified and filtered, the resulting dc would have the same polarity regardless of input polarity. Therefore a phase-sensitive rectifier or demodulator is required.

Such a circuit is similar in function to a dc restorer or clamper. Refer to Fig. 2 and assume the same conditions of balance apply as in the modulator, Fig. 1. However the ac reference source (transformer) now has a higher voltage to handle a much higher peak-to-peak signal. During the conducting half of the cycle (Fig. 3-a), the junction of both diodes and of R23 and C9 (Fig. 2) is effectively at ground potential. This clamps the most positive signal excursions at zero volts (Fig. 3-b). During the nonconducting half of the cycle (Fig. 3-c) the diodes are cut off and free to follow the signal to the −20-volt level. Now we actually have a pulsating dc signal which can be filtered through the relatively long time-constant RC filter (R23 C6 to recover the average value of the dc. Figs. 3-c and 3-d show the signals when the input to the amplifier is reversed.

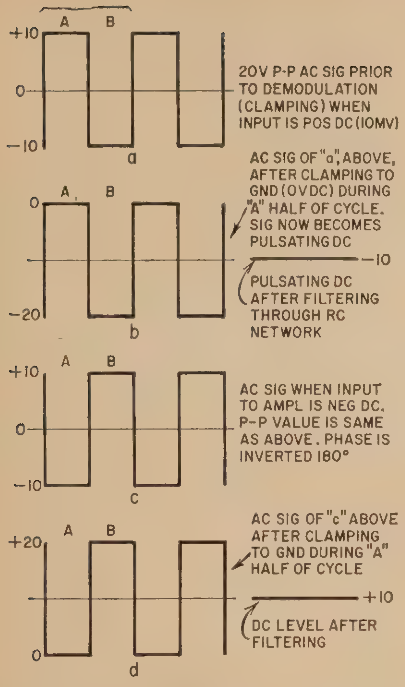

A
B
+10
0
−10
a
20V P-P AC SIG PRIOR TO DEMODULATION (CLAMPING) WHEN INPUT IS POS DC (10MV)
AC SIG OF "a", ABOVE, AFTER CLAMPING TO GND (0V DC) DURING "A" HALF OF CYCLE. SIG NOW BECOMES PULSATING DC
0
−20
b
−10
PULSATING DC AFTER FILTERING THROUGH RC NETWORK
AC SIG WHEN INPUT TO AMPL IS NEG DC. P-P VALUE IS SAME AS ABOVE. PHASE IS INVERTED 180°
c
+20
AC SIG OF "c" ABOVE AFTER CLAMPING TO GND DURING "A" HALF OF CYCLE
+10
DC LEVEL AFTER FILTERING
d

Fig. 3—Demodulator waveforms, theoretical.

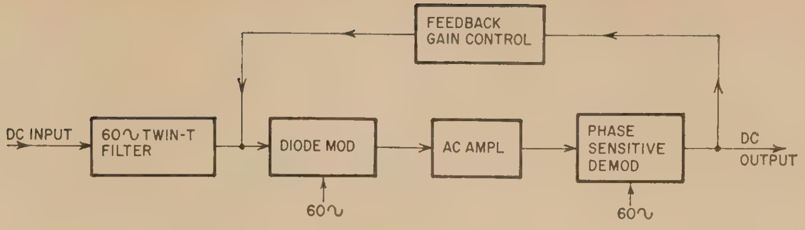

FEEDBACK GAIN CONTROL
DC INPUT
60∿ TWIN-T FILTER
DIODE MOD
AC AMPL
PHASE SENSITIVE DEMOD
DC OUTPUT
60∿
60∿

Fig. 4—Block diagram shows amplifier feedback loop.

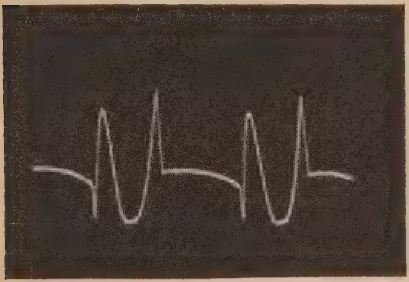
The input circuit includes a twin-T filter that rejects any 60-cycle ripple which might be on the dc to be amplified. If the 60-cycle component were not eliminated, it would be amplified, demodulated and appear as an error in the output. The block diagram (Fig. 4) shows signal flow. The ac section of the amplifier operates at full gain (×1,000) at all times. For gains of ×100 and ×10, fixed ratios of negative feedback are included in the loop. Because the 6.3-volt winding on T is not center-tapped, R17, R18 and R19 create a center tap which is variable over a limited range, to set exact modulator balance. As the power transformer is operated considerably below its rated output currents, the secondary voltages tend to be high. R22 in the primary reduces filament voltage to normal and avoids overloading D5 and C7.

Construction tips

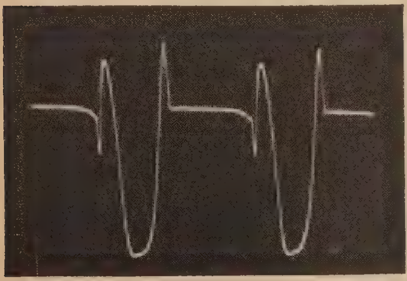
The complete circuit is shown in Fig. 5. Only a few of the components are critical as to value or placement. C4 and all adjacent components should be routed or located well away from any leads carrying 60-cycles ac. The leads connecting C4, D1, D2 and R4 and those connecting C4, R5 and pin 2 of V should be kept very short. For R13, R14, R17 and R18 I used 4,000-ohm 1% resistors because they were on hand. Actually any value between 3,000 and 5,500 ohms could be used, provided R13-R14, and R17-18 are matched within 1%. These resistors should be wirewound or deposited-carbon types for stability. Standard composition resistors have poor short- and long-term stability. Because of the convenience of the ac interlock connector I used for the power-line connection, an ac switch was deemed unnecessary. However, you can add one as shown in the schematic.

Test each of the 1N2070 diodes used in the unit for reverse current and use the two with the lowest leakage for D1 and D2. To test them, connect their cathodes to a positive 250-volt dc source, and measure the voltage at the anode end with a vtvm. The common lead of the vtvm should, of course, be returned to the negative side of the 250-volt source. Readings of 1 volt or less indicate a diode very satisfactory for use in the input modulator (D1, D2).

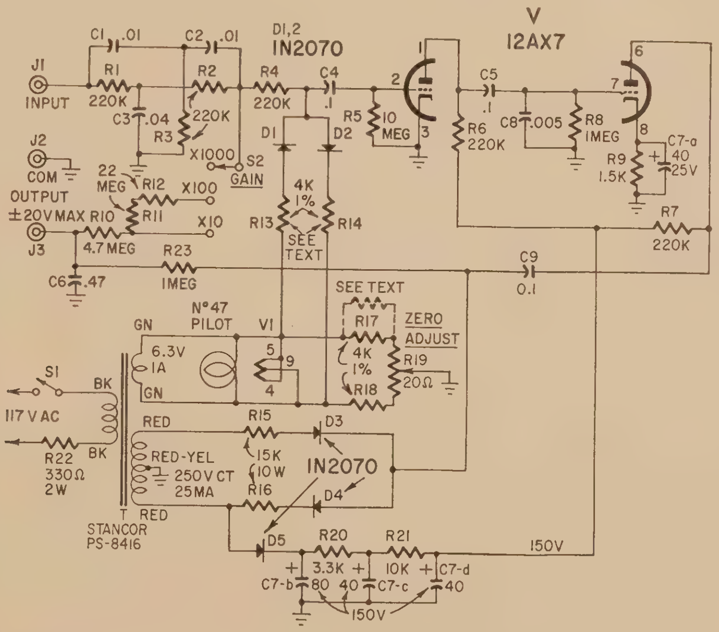
The forward characteristics of the two modulator diodes should also be very similar. Using the vtvm on its



Waveform at pin 6 of V1 with no input to amplifier, and output adjusted to zero.

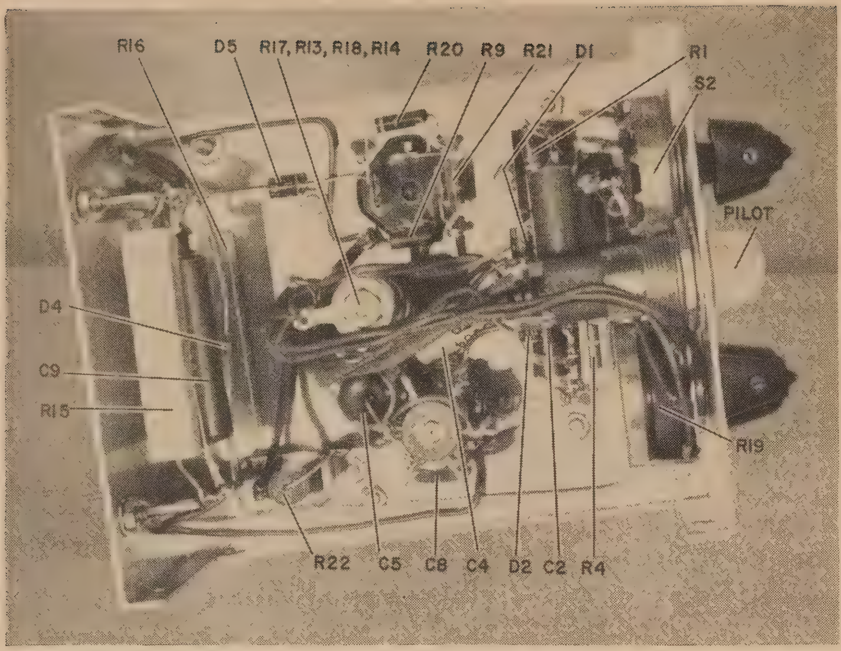


Waveform at pin 6 of V1 with 5-mv input and − 5 volts out. Amplitude is 14 volts peak to peak.


C1 .01
C2 .01
D1,2 1N2070
V 12AX7
J1 INPUT
R1 220K
R2
R4 220K
C4 .1
C3 .04
220K R3
X1000
S2 GAIN
D1
D2
R5 10 MEG
C5 .1
R6 220K
C8 .005
R8 1MEG
C7-a 40 25V
R9 1.5K
R7 220K
J2 COM
OUTPUT ±20V MAX
J3
22 MEG R12
X100
R10
R11
X10
4.7 MEG
R23 1MEG
C6 .47
4K 1%
R13
R14
SEE TEXT
C9 0.1
SEE TEXT
R17
ZERO ADJUST
R19 20Ω
4K 1%
R18
GN
No 47 PILOT
V1
6.3V 1A
S1
BK
117V AC
R22 330Ω 2W
RED
RED-YEL
250V CT 25MA
T
STANCOR PS-8416
R15 15K 10W
R16
D3
1N2070
D4
D5
R20 3.3K
R21 10K
150V
C7-b 80
40 C7-c
C7-d 40
150V

R1, R2, R3, R4, R6, R7—220,000 ohms
R5—10 megohms
R8, R23—1 megohm
R9—1,500 ohms
R10—4.7 megohms
R11, R12—22 megohms
R13, R14, R17, R18—matched pairs, 3,000 to 5,500 ohms, 1% (see text)
R15, R16—15,000 ohms, 10 watts, wirewound
R19—pot, 20 ohms
R20—3,300 ohms
R21—10,000 ohms
R22—330 ohms, 2 watts
All resistors ½-watt 10% unless noted
C1, C2—.01 µf
C3—.04 µf
C4, C5, C9—0.1 µf
C6—0.47 µf
C7—40-80-40-40 µf, 25-150-150-150 volts, can type electrolytic
C8—.005 µf, paper or ceramic
All capacitors 200 volts paper unless noted
D1, D2, D3, D4, D5—1N2070 silicon diodes
J1, J2, J3—binding posts
S1—spst toggle
S2—single-pole 3-position, shorting, rotary
T—power transformer: primary 117 volts; secondary, 250 volts ct, 25 ma; 6.3 volts, 1 amp (Stancor PS-8416 or equivalent)
V—12AX7
Socket, 9-pin miniature for V1, with shield
Case, 3 x 4 x 5 inches
No. 47 pilot lamp and holder
Miscellaneous hardware

Fig. 5—Circuit of the entire dc amplifier.



Parts layout inside the amplifier chassis.

lowest resistance scale, the forward resistance of the two selected diodes should match within 10%. Normally the diodes are well within these requirements but checking avoids getting an odd one in the critical area. Use care when soldering the diodes to avoid damage. The leads are solid silver and excellent thermal conductors. Grasp them between the solder point and the diode with long-nose pliers when soldering. Avoid cutting the lead short when possible.

Tests and adjustments

After checking wiring carefully for errors and poor solder connections, remove the 12AX7 and turn on the amplifier. Measure the voltage at the output terminal with a vtvm. If the reading is less than 5 volts, either polarity, the demodulator balance is satisfactory. If greater, the demodulator may be balanced by shunting R15 or R16 with additional resistance. If the output is positive, shunt R16 with values from 68,000 to 470,000 ohms until the output voltage is reduced. If negative, shunt R15 with the same range of values.

Next install the tube. Measure the heater voltage. If it is not within 10% of 6.3 volts, change R22 to a value that corrects the voltage. Place the gain switch (S2) on ×1,000. Connect a 1.5-volt battery to the input (positive to the input terminal, negative to common) and measure the output voltage. It should be negative. If not, reverse the 6.3-volt leads from T1.

The polarity of the dc output from the amplifier is always the opposite of the input polarity. There are two reasons for this: the output must be inverted if negative feedback is to be used to control the gain, and if used as an operational amplifier for analog functions such as an integrator, or summing device, this polarity inversion is necessary. The reversed polarity should cause no difficulty as long as it is known. However, if the application requires the same polarity out, reverse one of the secondaries of T, and remove S2, R10, R11 and R12. This of course removes the adjustable-gain feature and provides full gain at all times.

Remove the battery and short the input to common. Try to zero the output voltage with the ZERO ADJUST control. If you can't, shunt R17 or R18 with a resistance substitution box and select a value that allows the control to zero the output voltage when near the center of its range. This control has a minimum effect on the ×10 range because of the large amount of feedback. During the final selection of this shunt resistor and testing, an earth ground to the chassis is very helpful. It is not required for operation when the bottom cover is installed.

Applications

One use for the amplifier is to measure very low values of resistance such as meter shunts or switch contacts. To do this a known current is passed through the conductor to be measured. The amplifier is used to determine the voltage drop across the portion of the conductor containing the unknown resistance, and the value is then computed using Ohm's law.

Insulation resistance can be measured by applying a relatively high known voltage to the material. Since the current sensitivity of the amplifier is known (.0008 μa per volt out), the resistance may be computed by noting the current passed by the material. The amplifier is also useful as a null indicator for dc bridge measurements, as an air ionization indicator, for measuring thermocouple potential, and as an operational amplifier for performing analog functions. **END**

The Resonant Sky

(Continued from page 25)

beneficial inventions. No one need ever again be lost, for a simple position-and-direction-finding device could be incorporated in the receiver, based on the principle of today's radar navigational aids. And in case of danger or accident, help could be summoned merely by pressing an "Emergency" button.

For global phone and vision services, enabling men to confer with each other anywhere on the planet, are only a beginning. Even now we have data-handling systems linking together factories and offices miles apart, controlling nationwide industrial empires. Electronics is already permitting the decentralization which rising rents and transport costs—not to mention the threat of the mushroom cloud—encourage more strongly every year.

The business of the future may be run by executives who are scarcely ever in each other's physical presence. It will not even have an address or a central office—only the equivalent of a telephone number. The time may come when half the world's business will be transacted through vast memory banks beneath the Arizona desert, the Mongolian steppes, the Labrador muskeg. For all spots on earth, of course, would be equally accessible to the beams of the relay satellites: To sweep from pole to pole would mean merely turning the directional antennas through seventeen degrees.

And so the captains of industry of the twenty-first century may live where they please, running their affairs through computer keyboards and information-handling machines in their homes. Administrative and executive skills are not the only ones which would thus become independent of geography. Distance has already been abolished for the three basic senses of sight, hearing, and touch—the latter, thanks to the development of remote-handling devices in the atomic energy field. *Any* activity which depends on these senses can, therefore, be carried out over radio circuits. The time will certainly come when surgeons will be able to operate a world away from their patients, and every hospital will be able to call on the services of the best specialists, wherever they may be.

An application of satellites which has already been considered in some detail by the astronautical engineers is what has been called the orbital post office, which will probably make airmail obsolete in the quite near future. Modern facsimile systems can automatically transmit and reproduce the equivalent of an entire book in less than a minute. By using these techniques, a single satellite could handle the whole of today's transatlantic correspondence.

A few years from now, when you wish to send an urgent message, you will purchase the standard letter form on which you will write or type whatever you have to say. At the local office the form will be fed into a machine which scans the marks on the paper and converts them into electrical signals. These will be radioed to the nearest relay satellite, routed in the appropriate direction round the earth, and picked up at the destination where they are reproduced

(Continued on page 46)

color TV service hints

Simple solutions to irritating convergence and purity troubles

By WARREN ROY

ONE COMMON TROUBLE IN REPLACING a color picture tube is that no matter how carefully you adjust the video drive controls, you can't get a clean black-and-white picture. This is caused by differences in the efficiency of the phosphors of the old tube as compared to the phosphors of the newer replacement tube. It is easy to correct in General Electric CW, Sylvania 576 and RCA CTC10 and later chassis.

To adjust for this trouble, first find which phosphor is the weak one. Set up the set, following the manufacturer's black-and-white tracking instructions carefully. When finished, step back and look at the picture.

If the screen has taken on a cyan tint, change the connections at the drive controls to match *a* in the figure. If the picture has a magenta tint, set up the circuit to match *b*. And if the picture looks yellow, set up the circuit to match *c*.

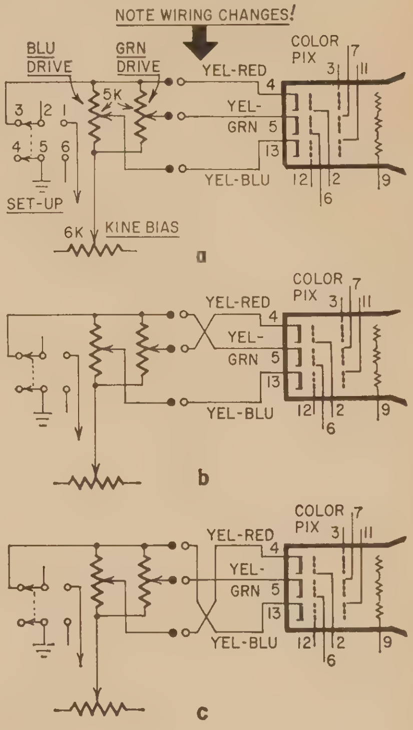
These changes will compensate for the weak phosphor and make it possible to get good black-and-white tracking once again. Changing drive-control connections should not affect the original settings of the screen controls. But it may be wise to recheck the screen controls anyway to insure the best possible tracking.

Poor purity

When purity is a problem, start by degaussing the receiver—even if it was already done a half-hour before. Then adjust purity rings and yoke positioning, following the manufacturer's recommendations. If purity is still not good, check the settings of the static convergence magnets and check picture centering.

Occasionally there will be a minor impurity near the edge of the picture or raster. If rechecking the purity does not get rid of it, get a couple of pincushion magnets and fasten them to the picture-tube mounting near the location of the impurity on the screen. Then move the magnets around to find the position that clears up the impurity. Fasten in place with a drop of cement.

END



(Right) Deliberate wire crossing helps compensate for differences in phosphor efficiencies in old and new color tubes. Diagrams a, b and c show what to do for cyan-, magenta- and yellow-tinted pictures, respectively.

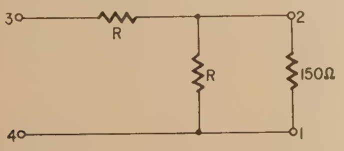
WHAT'S YOUR EQ?

Three puzzlers for the student, theoretician and practical man. They may look simple, but double-check your answers before you say you've solved them. If you've got an interesting or unusual answer send it to us. We are especially interested in service stinkers or engineering stumpers on actual electronic equipment. We are getting so many letters we can't answer individual ones, but we'll print the more interesting solutions (the ones the original authors never thought of). We will pay $10 and up for each one accepted. Write EQ Editor, Radio-Electronics, 154 West 14th St., New York, N.Y.

Answers for this month's puzzlers are on page 67.

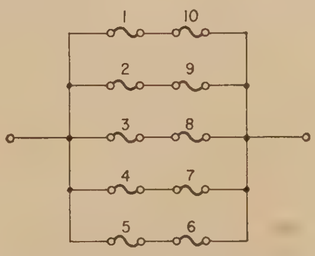
L-pad Puzzler

Two equal resistors form an L-pad. When a load of 150 ohms is connected



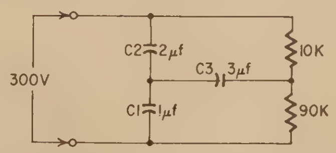
to terminals 1 and 2, an ohmmeter shows 300 ohms between terminals 3 and 4. What are the values of the resistors?—*Kendall Collins*

Fussy Fuses



The number next to each fuse is its current rating in amperes. What current will this fuse combination carry?—*Steve Stumph*

Voltage Divider?



After charging current stops, what are the voltages across C1, C2 and C3? —*Cleve G. Cleveland*

END

With the help of a little arithmetic, 11 crystals do the work of 46

By ROBERT F. SCOTT
TECHNICAL EDITOR

frequency synthesis improves CB coverage

PRECISION FREQUENCY CONTROL IS ONE of the basic requirements for CB transmitters. A crystal-controlled oscillator is almost universally used to insure the precision and stability required by FCC regulations. *Frequency synthesis*—a relatively new development—provides crystal-controlled transmission and reception with less than one-fourth the number of crystals previously required.

Most class-D base or mobile transceivers are designed for crystal-controlled transmission and reception on 5 to 8 channels plus continuous tuning over all 23 channels. To transmit on other channels, you plug in other crystals and possibly touch up the transmitter tuning. If you want crystal-controlled transmission and reception on all channels, you need a total of 46 crystals.

Hammarlund and Polytronics Lab have just introduced transceivers that use only 11 crystals to transmit and receive on all 23 channels. The fundamentals, or fundamentals and harmonics, of two or more precision signals are combined to produce other related precision frequencies. If we have a number of channels 1 kc apart, it is possible to use relatively few crystals, with frequency synthesis to tune to the channel frequencies as easily as with a vfo.

Poly-Comm Senior 23

Fig. 1 shows how Polytronics Lab uses frequency synthesis and 11 crystals for full frequency control in the receiver and transmitter sections of the Poly-Comm Senior 23. In analyzing the circuit, refer to the channel frequencies in the table.

The CHANNEL SWITCH (S1) has

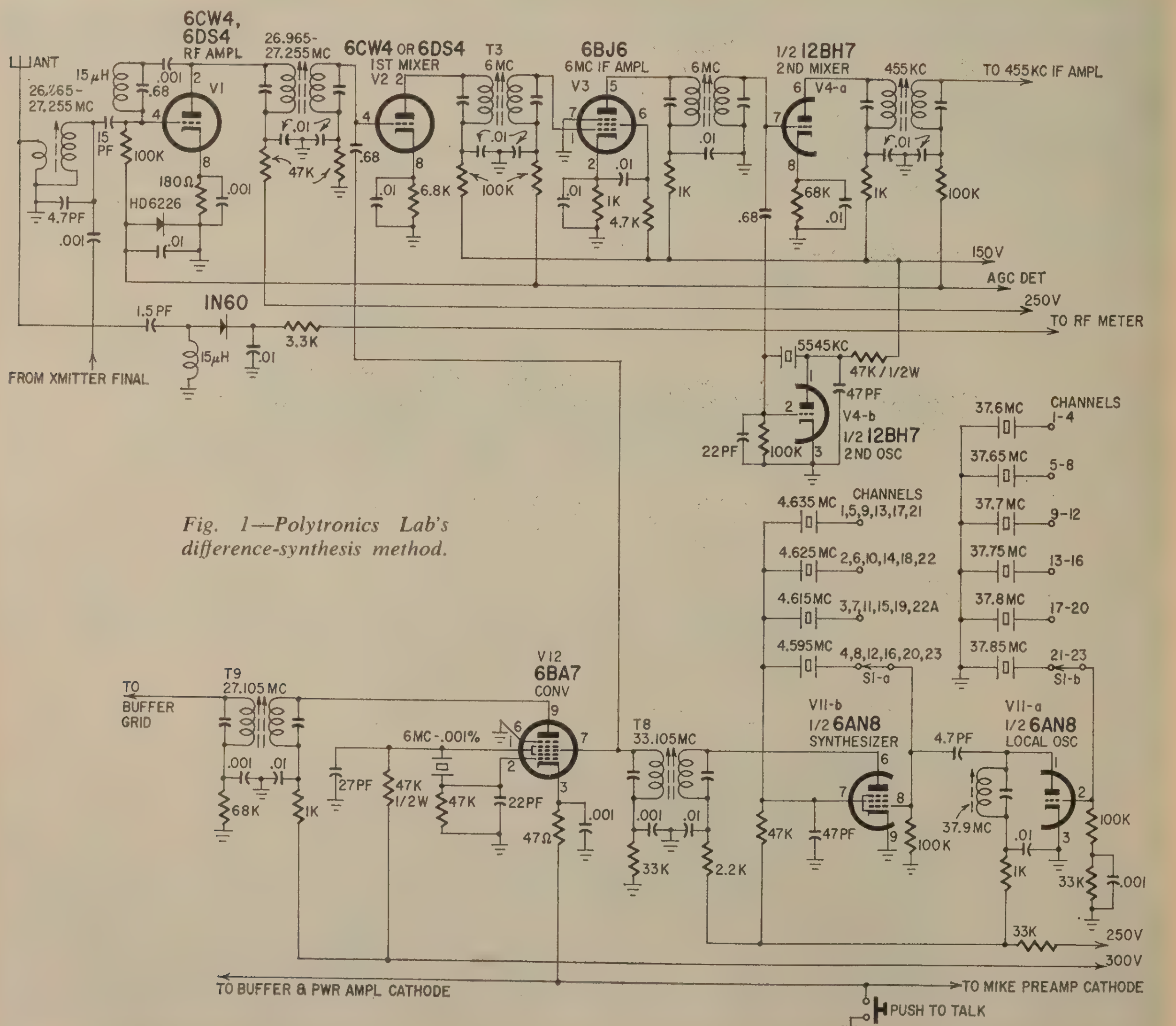

6CW4,
6DS4
RF AMPL
V1
ANT
15µH
.001
.68
26.965-27.255 MC
15 PF
100K
180Ω
.001
HD6226
4.7PF
.001
.01
26.965-27.255 MC
.01
47K
6CW4 OR 6DS4
1ST MIXER
V2
.68
.01
6.8K
T3
6MC
.01
100K
6BJ6
6MC IF AMPL
V3
.01
.01
1K
4.7K
6MC
.01
1K
1/2 12BH7
2ND MIXER
V4-a
.68
68K
.01
455KC
.01
1K
100K
TO 455KC IF AMPL
150V
AGC DET
250V
TO RF METER
1.5PF
IN60
3.3K
15µH
.01
FROM XMITTER FINAL
5545KC
47K/1/2W
47PF
V4-b
1/2 12BH7
2ND OSC
22PF
100K
37.6MC
CHANNELS 1-4
37.65MC
5-8
37.7MC
9-12
37.75MC
13-16
37.8MC
17-20
37.85MC
21-23
S1-b
4.635 MC
CHANNELS 1,5,9,13,17,21
4.625 MC
2,6,10,14,18,22
4.615MC
3,7,11,15,19,22A
4.595MC
4,8,12,16,20,23
S1-a
V11-b
1/2 6AN8
SYNTHESIZER
47K
47PF
100K
4.7PF
V11-a
1/2 6AN8
LOCAL OSC
37.9MC
.01
1K
100K
33K
.001
33K
250V
300V
V12
6BA7
CONV
6MC-.001%
27PF
47K 1/2W
47K
22PF
47Ω
.001
T8
33.105MC
.001
.01
33K
2.2K
T9
27.105 MC
TO BUFFER GRID
.001
.01
68K
1K
TO BUFFER & PWR AMPL CATHODE
TO MIKE PREAMP CATHODE
PUSH TO TALK

Fig. 1—Polytronics Lab's difference-synthesis method.

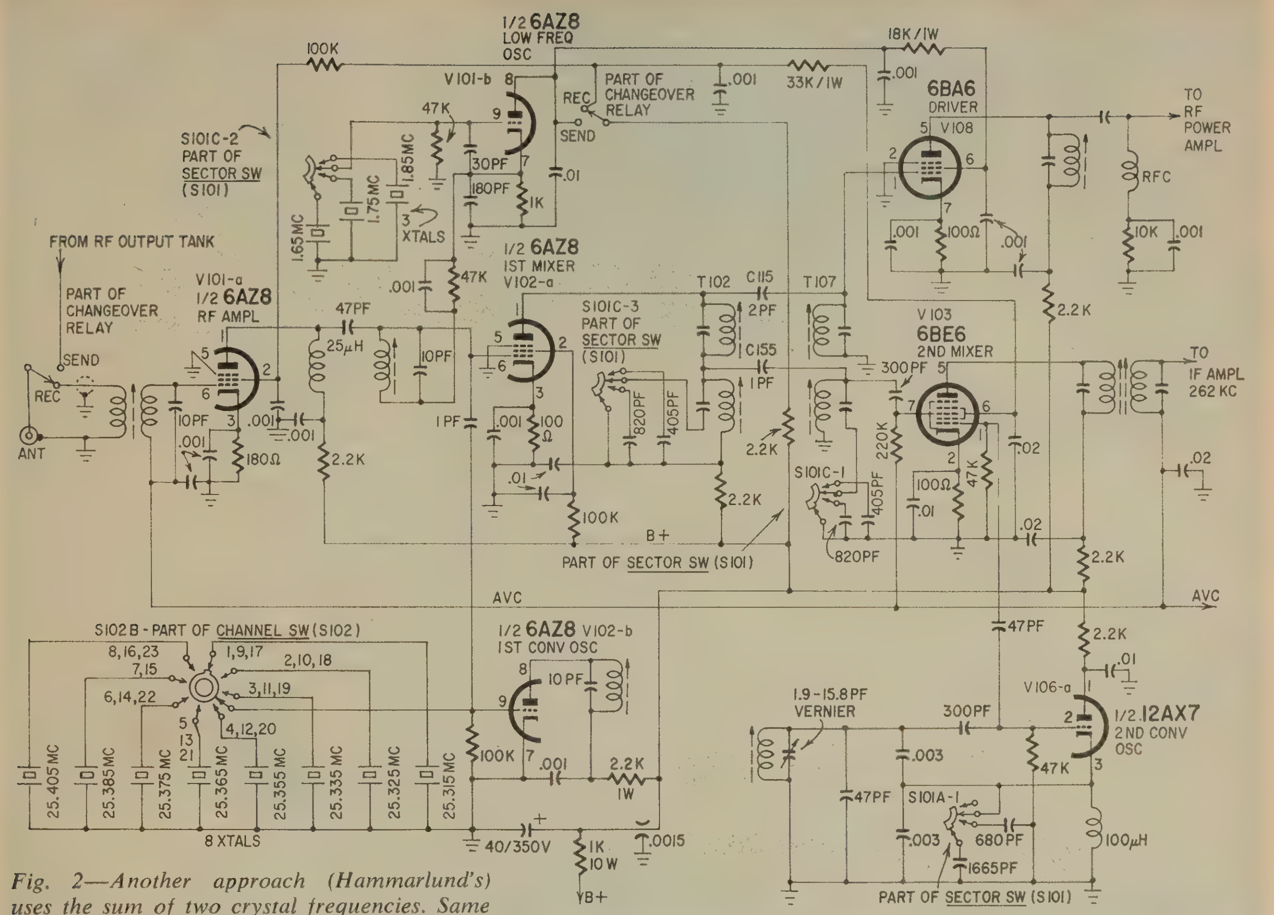

1/2 6AZ8
LOW FREQ
OSC
100K
V101-b
47K
PART OF
CHANGEOVER
RELAY
REC
SEND
.001
33K/1W
18K/1W
.001
6BA6
DRIVER
V108
TO
RF
POWER
AMPL
RFC
10K
.001
S101C-2
PART OF
SECTOR SW
(S101)
1.85 MC
1.75 MC
1.65 MC
30PF
180PF
1K
.01
3
XTALS
FROM RF OUTPUT TANK
V101-a
1/2 6AZ8
RF AMPL
PART OF
CHANGEOVER
RELAY
SEND
REC
ANT
.001
47K
1/2 6AZ8
1ST MIXER
V102-a
47PF
25μH
10PF
10PF
.001
.001
.001
180Ω
2.2K
1 PF
.001
100Ω
.01
100K
S101C-3
PART OF
SECTOR SW
(S101)
820PF
405PF
T102
C115
2PF
C155
1 PF
T107
2.2K
2.2K
B+
PART OF SECTOR SW (S101)
.001
100Ω
.001
2.2K
V103
6BE6
2ND MIXER
300PF
220K
S101C-1
405PF
820PF
100Ω
.01
47K
.02
.02
TO
IF AMPL
262 KC
.02
2.2K
AVC
AVC
S102B - PART OF CHANNEL SW (S102)
8,16,23
1,9,17
2,10,18
7,15
6,14,22
3,11,19
5
13
21
4,12,20
25.405 MC
25.385 MC
25.375 MC
25.365 MC
25.355 MC
25.335 MC
25.325 MC
25.315 MC
8 XTALS
1/2 6AZ8 V102-b
1ST CONV OSC
10 PF
100K
.001
2.2K
1W
40/350V
1K
10 W
.0015
B+
47PF
2.2K
.01
V106-a
1/2 12AX7
2ND CONV
OSC
1.9-15.8PF
VERNIER
300PF
.003
47K
47PF
S101A-1
.003
680PF
1665PF
100μH
PART OF SECTOR SW (S101)

Fig. 2—Another approach (Hammarlund's) uses the sum of two crystal frequencies. Same total number of crystals.

been drawn in simplified operational form. It is a 23-position switch but S1-a and S1-b are drawn to show the crystals that they select for each channel. For example, S1-b selects the 37.600-mc crystal on channels 1 through 4, the 37.650-mc crystal for channels 5 through 8 and so on.

Let's start with the transceiver tuned to channel 10 and see how the 27.075-mc transmitter frequency is developed. The local oscillator (V11-a) generates a 37.700-mc signal and feeds it to the synthesizer—a conventional pentode converter whose grid–screen grid circuit is a Pierce oscillator operating (for channel 10) at 4.625 mc. Sum and difference frequencies are developed in V11-b's plate circuit. The difference frequency of 33.075 mc (37.700 − 4.625 = 33.075) is fed through T8 to the signal grid of the 6BA7 converter (V12). (Here again we have a conventional circuit similar to those in most crystal-controlled superhets.)

The 33.075-mc signal on V12's signal grid beats with the 6-mc signal from the oscillator circuit, and the difference frequency of 27.075 mc is picked off by T9. This is the frequency we are looking for. This signal is amplified by the buffer and fed to the final power amplifier.

CB CHANNEL NUMBERS AND FREQUENCIES

Channel	Freq *(mc)*	Channel	Freq *(mc)*
1	26.965	13	27.115
2	26.975	14	27.125
3	26.985	15	27.135
4	27.005	16	27.155
5	27.015	17	27.165
6	27.025	18	27.175
7	27.035	19	27.185
8	27.055	20	27.205
9	27.065	21	27.215
10	27.075	22	27.225
11	27.085	23	27.255
12	27.105		

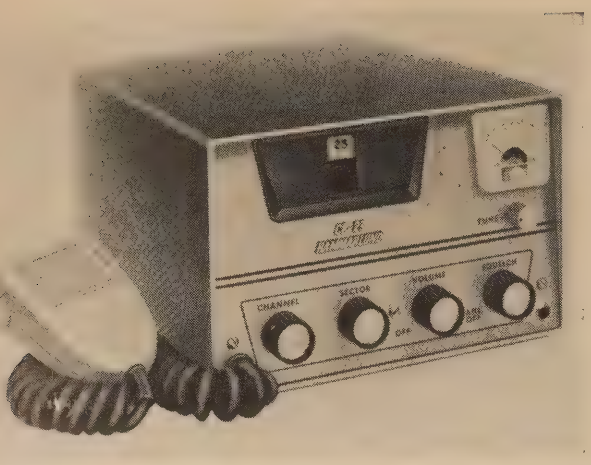
Now, let's take a look at the receiver circuits. The receiver is a dual-conversion type with a 6-mc first i.f. An incoming channel-10 signal is amplified and fed to the grid of the first mixer along with the 33.075-mc from the synthesizer. These two signals beat and the 6-mc difference frequency is fed through T3 to the 6-mc first i.f. amplifier. We could amplify this signal further and then pass it on to the detector. However, a high i.f. eliminates images but lacks selectivity and gain. So the 6-mc signal is fed to the second mixer where it is heterodyned with the 5.545-mc signal from the second oscillator to produce the 455-kc second i.f.

To get the real picture of how frequency synthesis works in the Polytronics circuit, get a pencil and paper and see how the desired frequencies are developed on other channels. Just remember that, in this circuit, the transmitter output frequency equals the local oscillator frequency *minus* the synthesizer frequency *minus* 6 mc. The injection frequency for the receiver's first mixer is equal to the local oscillator frequency minus the synthesizer frequency.

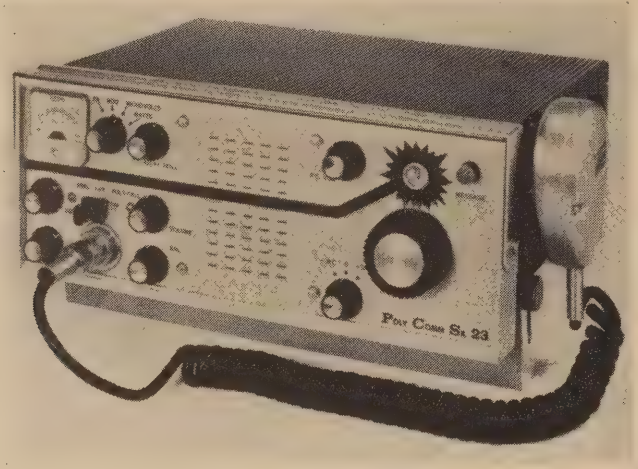
Hammarlund CB-23

In this model, the channel is determined by the settings of the CHANNEL and SECTOR switches (S102 and S101, respectively). The CHANNEL switch is an 8-position unit without stops. The SECTOR switch has 3 positions and corresponds to the band switch on a radio. It is ganged to a mask that covers the unused bands on the CHANNEL dial. When the SECTOR switch is in its extreme left position (let's call it position 1), the CHANNEL selector covers channels 1 through 8. Channels 9 through 16 and 17 through 23 are selected when the SECTOR switch is in positions 2 and 3, respectively.

Fig. 2 is a simplified diagram of



Hammarlund model CB-23



Polytronics' Poly-Comm Senior 23.

the frequency-determining section of the CB-23. Some switching, not particularly pertinent to this discussion, has been eliminated for simplicity. We'll stick to channel 10 and see how the transmitting frequency (27.075 mc) is made.

The first conversion oscillator (V102-b) sends a 25.325-mc signal to the grid of the first mixer (V102-a) where it combines with the 1.750-mc signal from the low-frequency oscillators. The sum frequency of 27.075 mc (25.325 + 1.750) is fed through bandpass network T102-C115-T107 to the driver and then to the transmitter's final amplifier. In this circuit, the desired frequency is the *sum* of two frequencies, whereas in the Poly-Comm we used the *difference* frequency.

REV.
J.S.
SMITH
Roblin

Now to the receiver. Its first i.f. is 1.65 mc in the first sector, 1.75 mc in the second and 1.85 mc in the third. Sections of the SECTOR switch select capacitors that tune the first mixer plate and second mixer grid circuits to the correct i.f.

We are still on channel 10. The output of the first conversion oscillator is mixed with the incoming signal at the grid of the first mixer to develop the 1.75-mc first i.f. This signal passes through the bandpass network consisting of C155 and the bottom coils in T102 and T107 to the second mixer grid.

The conversion signal for the second mixer comes from V106-a, a Colpitts oscillator whose frequency is selected by the SECTOR switch. Its output is 1.388 mc in sector 1, 1.488 mc in sector 2 and 1.588 mc in sector 3. Since we are on channel 10, the 1.488-mc signal from V106-a beats with the 1.750-mc first i.f. to produce the 262-kc second i.f. A single 262-kc i.f. amplifier feeds the detector, avc and anl circuits. The vernier tuning control varies the second conversion oscillator's frequency ± 3 kc to compensate for minor frequency variations in other transmitters. It doesn't affect transmitter frequency. END

The Resonant Sky

(Continued from page 42)

on a blank form identical with the one you inscribed. The transmission itself would take a fraction of a second; the door-to-door delivery would extend this time to several hours, but eventually letters should never take more than a day between any two points on the earth.

Perhaps a decade beyond the orbital post office lies something even more startling—*the orbital newspaper*. This will be made possible by more sophisticated descendants of the reproducing and facsimile machines now found in most up-to-date offices. One of these, working in conjunction with the TV set, will be able on demand to make a permanent record of the picture flashed on the screen. Thus when you want your daily paper, you will switch to the appropriate channel, press the right button —and collect the latest edition as it emerges from the slot. It may be merely a one-page news sheet; the editorials will be available on another channel—sports, book reviews, drama, advertising, on others. We will select what we need, and ignore the rest, thus saving whole forests for posterity.

Nor will the matter end here. Over the same circuits we will be able to conjure up, from central libraries and information banks, copies of any document we desire from Magna Charta to the current earth–moon passenger schedules. Even books may one day be "distributed" in this manner, though their format will have to be changed drastically to make this possible.

All publishers would do well to contemplate these really staggering prospects. Most affected will be newspapers and pocket books; practically untouched by the coming revolution will be art volumes, and quality magazines, which involve not only fine printing but elaborate manufacturing processes. The dailies may well tremble; the glossy monthlies have little to fear.

Will there be time to do any work at all on a planet saturated from pole to pole with fine entertainment, first-class music, brilliant discussions, and every conceivable type of information service? Even now, it is claimed, our children spend a sixth of their waking lives glued to the cathode-ray tube. We are becoming a race of watchers, not of doers.

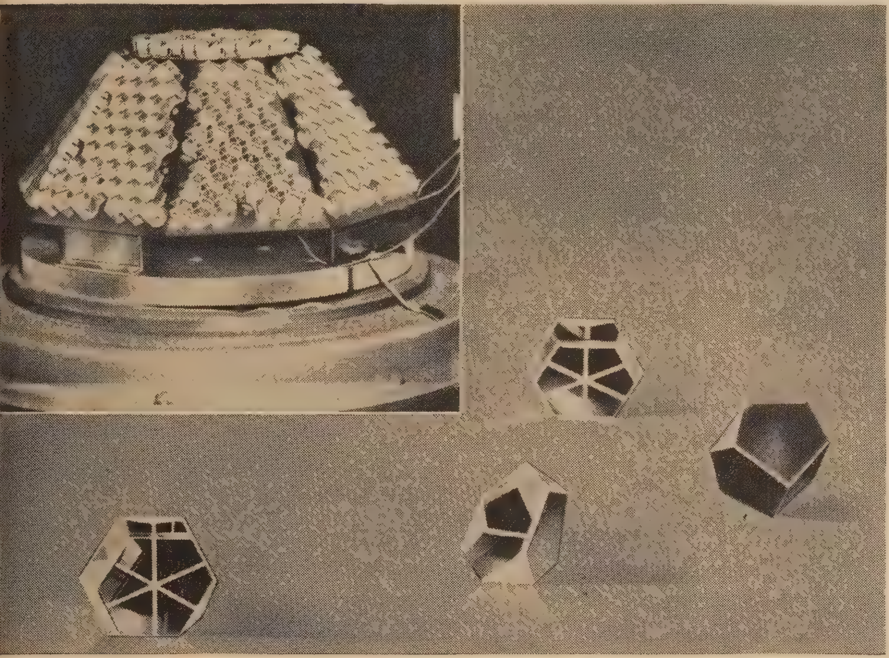
If this is so, then the epitaph of our race should read, in fleeting, fluorescent letters: *Whom the Gods would destroy, they first give TV.* END

◆

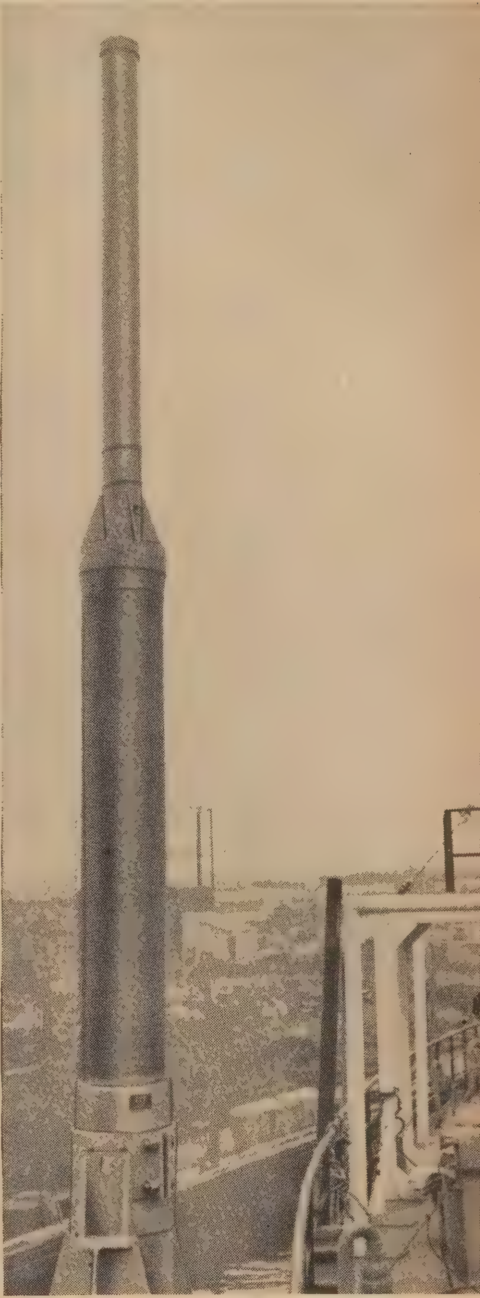
Now—Transistor Gear Changing Equipment

Optional equipment on Renault 1963 Dauphin models is an electronically controlled gear-change system. The transistor type circuit shifts a standard manual transmission automatically. The system also features an electromagnetic clutch coupling unit in which the clutch is engaged by magnetizing a ferromagnetic powder in an air gap between an outer drum and inner hub.

What's New

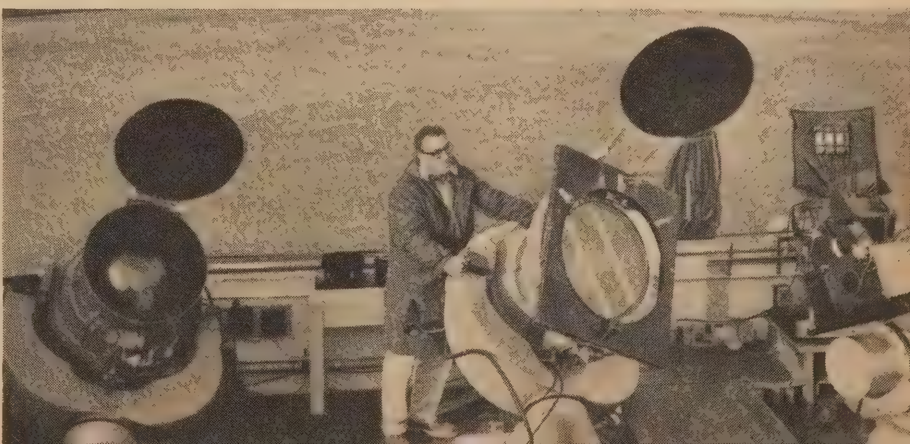


CORNER REFLECTORS will be used on the S-66 polar ionosphere beacon satellite to reflect a tracking laser beam back to earth. The photo shows four of the reflectors and the assembled array. The satellite will carry 360 of these reflectors in nine reflecting arrays, each containing 40 reflectors bonded together, and mounted on a truncated cone, as shown in the insert. The left reflector in the foreground shows the hexagonal face that points toward the earth; the center a side view; and right the back view, showing the deposited aluminum reflecting surface. The reflectors are made of fused silica, a special glass with high resistance to radiation in space.



HELICYL. New helical type antenna installed on the Air Force's Advanced Range Instrumentation Ships (ARIS) covers medium- and high-frequency (21–30 mc) bands, and is remotely tunable. The antenna, designed by ITT Federal Laboratories, is encased in epoxy-bonded glass fiber. The lower cylinder contains the helical antenna coil. The upper part contains the top-loading capacitor and the shaft for the tuning equipment. Tuning is by a rotating slider that contacts the coil in the larger, lower section.

RE-ENTRY BLACKOUT STUDY EQUIPMENT uses entirely optical receiver. Three meteor cameras, controlled by three tracking radars, are focused on the re-entering body. The super-Schmidt camera on left helps pinpoint position of luminous trail against a star background and provides velocity information. Center Super-Schmidt and small Schmidt on right act as spectrographs to analyze radiation from the re-entering body. Separated into two main spectra, light is analyzed by two electronic spectrophotometers, one of which measures 10 channels in the infrared region (0.6 to 4 microns); other, with 30 channels, measuring light between 0.3 and 0.6 micron (visible and ultraviolet). Results of infrared analysis are recorded on magnetic tape; those of visible light by counters which integrate quanta of light received over 0.1-second periods in the 30 visible-ultraviolet channels.



By FORREST H. FRANTZ, SR.

Beginner's Lab for Pennies

All you need is a calibrated capacitor and a standard inductance — make them yourself and you're ready to go

A CALIBRATED CAPACITOR AND A STANDARD inductance coil brings the world of precision radio-frequency measurement to your fingertips. With a calibrated capacitor, a standard inductance coil and a signal generator (or radio stations of known frequency), you can measure capacitance, inductance, impedance and Q. I'll give details for calibrating an inexpensive tuning capacitor and specifications for a standard inductance coil that you can build for a few cents in this article. The serious technician, ham or experimenter is cheating himself if he doesn't have a calibrated capacitor and a standard inductance coil among his instruments.

You can salvage the capacitor from an old radio and use only one section. Or you can buy a capacitor like the one I used for less than a buck. You can use a ready-made case or install your capacitor in a cigar box. Your cost can run from almost nothing to a few dollars.

The auxiliary equipment needed to make measurements is a vtvm with an rf probe. An rf signal generator is desirable, but you can substitute strong local broadcast signals. If you're a beginner and lack some of the equipment, come along on a reading binge anyway! You'll find that you can do a lot in electronics with very little if you know basic principles.

Winding the coil

To calibrate a capacitor and measure capacitance by the Q-meter* method, the first requirement is a standard inductance coil. Its inductance is 100 μh and it is simple to construct. Simply wind 91 turns of No. 30 enameled magnet wire on a ¾-inch-diameter form. Wind the coil close, but without any turn overlaps. The winding will occupy about 1 inch of the coil length.

I wound my coil on a piece of ¾-inch-diameter cardboard tube. You may use a plastic or bakelite form if you wish, but it isn't necessary. Make two small holes near each end but with $1\frac{1}{16}$ inches between each set of holes (Fig. 1). Use an ice pick or a very small drill to make the holes. Start the winding by looping the wire around through the set of holes at one end of the coil several times. Leave an inch or two of wire sticking out from the coil. Place the spool of wire on a nail or a rod fastened in the vertical position on a board or in a vise as shown in Fig. 2. Then turn the coil form and smooth the wire as you wind it on the form. The spool–spindle combination should have enough friction to keep the wire under tension so you can wind the coil tightly. If tension is too great, the wire may break. Count the turns to 91 and stop winding. Pass the wire through one of the small holes you've provided and then loop through the other one as you did on the other end of the coil.

Scrape the enamel off the wire ends, double the ends back on themselves, and tin them. Use a hot, clean soldering iron and rosin-core solder for this and any subsequent soldering work. Apply a thin coat of coil dope, Duco cement, collodion or finger-nail polish to the coil windings to hold the turns in place.

Next—the capacitor

The calibrated capacitor is housed in a bakelite case and has additional terminals to facilitate measurements. The circuit arrangement is in Fig. 3.

First, drill the panel according to the layout of Fig. 4. All holes are $\frac{3}{16}$-inch diameter except for the ⅝-inch hole for the tuning capacitor shaft.

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* An instrument consisting of a signal generator, a calibrated capacitor and a standard inductance coil which uses the resonance tuning principle (used in receivers) for the measurement of L, C, Z and Q.

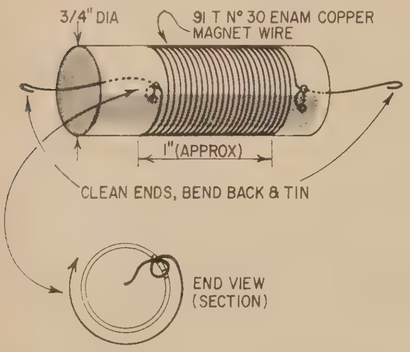

3/4" DIA
91 T N° 30 ENAM COPPER MAGNET WIRE
1"(APPROX)
CLEAN ENDS, BEND BACK & TIN
END VIEW (SECTION)

Fig. 1—Construction details of the 100-μh standard coil.

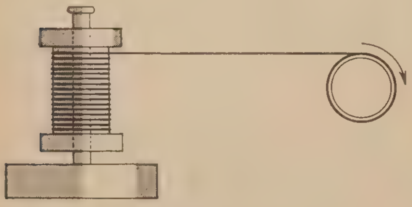


Fig. 2—Coil-winding method.

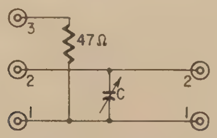


Fig. 3—Calibrated capacitor, showing where to connect binding-post terminals.

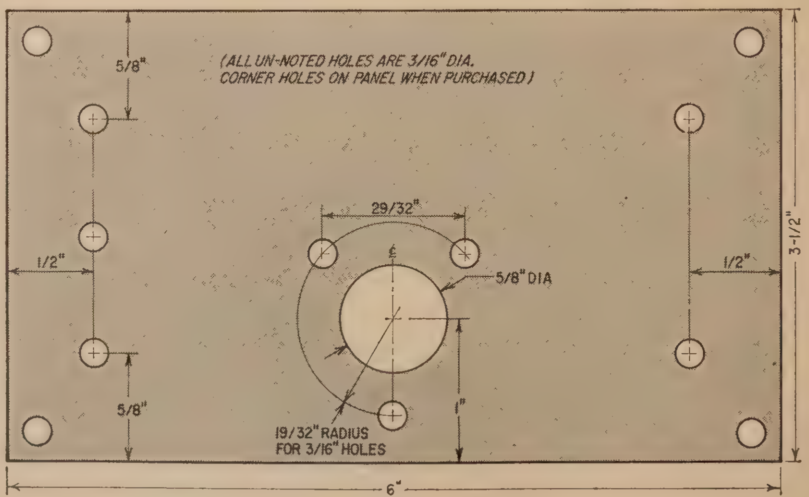
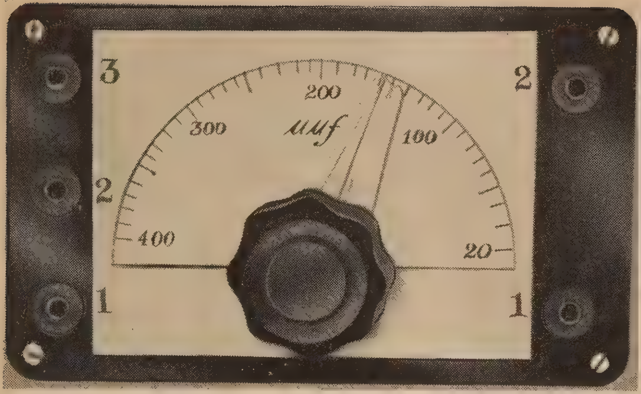
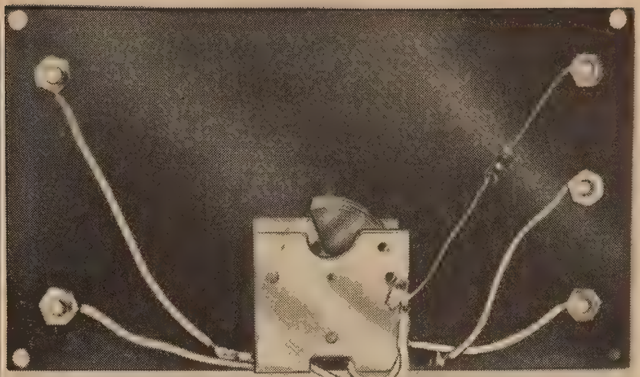

5/8"
(ALL UN-NOTED HOLES ARE 3/16" DIA.
CORNER HOLES ON PANEL WHEN PURCHASED)
29/32"
℄
1/2"
5/8" DIA
1/2"
3-1/2"
5/8"
1"
19/32" RADIUS FOR 3/16" HOLES
6"

Fig. 4—Panel layout for the calibrated capacitor.



Front view of the calibrated capacitor mounted in its bakelite case.



Rear view reveals connections to the capacitor.

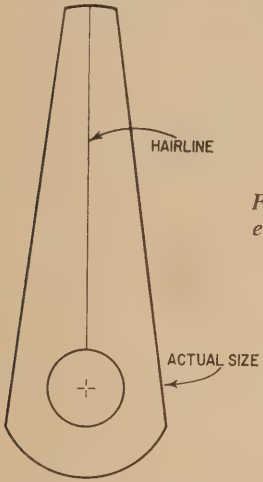


Fig. 5—Pointer knob detail.

Mark off the hole positions with an ice pick or center punch and drill 3/32-inch-diameter starter holes. Then enlarge all holes to 3/16-inch diameter. Finally, enlarge the tuning-capacitor shaft hole to 5/8-inch diameter. Place the panel on a piece of scrap wood during drilling to avoid breakage.

Next, cut the variable capacitor shaft so 9/16-inch extends beyond the bushing. Place the part of the shaft to be discarded in the vise while you saw it. Catch the capacitor with your hand when it drops free. Dress the edge of the shaft with a file to remove burrs. Be careful *not* to let sawdust or filings get between the capacitor plates.

Mount the variable capacitor and the five binding posts on the panel. (Cement a piece of aluminum foil to the panel and ground it to the capacitor frame for shielding if you use the bakelite panel. Extend the foil to fit under the common terminals numbered 1, but not under the others.) Insert a 1/16-inch-thick washer between the back of the panel and the variable capacitor under each of the screw holes. Fasten the capacitor with 1/4-inch 6-32 screws. The two bottom binding posts (ground common connection) are black, and the other three are red.

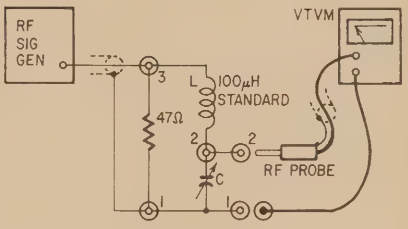
Remove the trimmer screw on the capacitor and bend the small trimmer plate away from the small stator on the side of the capacitor. Replace the mica washer and fasten the screw down tight, leaving the trimmer plate free. Then proceed with the wiring.

Make the pointer knob out of a 1/16-inch-thick piece of clear plastic. The pattern and size are shown in Fig. 5. Make the hairline by laying a straightedge on the plastic and scratching with an ice pick or other sharp instrument. Then fill the hairline with India ink. Cement the pointer (hairline down) to the knob with Duco cement. Position the plastic pointer so the setscrew is away from the pointer. Also be sure you get the pointer hole centered on the knob hole center.

Next, cut a piece of high-quality cardboard or paper (that will take ink without smudging) to 3 1/4 x 4 3/8 inches. Locate the shaft center at the middle of the long dimension and 7/8 inch from the bottom along the height dimension. Then, with a compass, ink in a 2-inch radius arc and pencil in 1 15/16- and 1 7/8-inch radius arcs, using the capacitor-shaft center mark as center. Pencil an 11/16-inch-radius circle using this same center. Cut out this circle with a pair of scissors. Center this piece of paper on the variable-capacitor shaft center on the front of the panel and fasten temporarily with cellophane tape at the corners. Fasten the knob on the variable capacitor shaft. Now you're ready to calibrate. When calibration is completed, the piece of paper can be removed and the calibrations inked in. The pencil arcs were provided as guides for calibration mark lengths.

TABLE I

c (pf)	f (mc)	c (pf)	f (mc)	c (pf)	f (mc)
10	5.04	130	1.39	250	1.005
20	3.55	140	1.34	260	0.988
30	2.90	150	1.30	270	0.969
40	2.51	160	1.26	280	0.950
50	2.25	170	1.22	290	0.935
60	2.05	180	1.19	300	0.920
70	1.90	190	1.14	310	0.905
80	1.78	200	1.12	320	0.890
90	1.68	210	1.10	330	0.875
100	1.59	220	1.08	340	0.863
110	1.51	230	1.05	350	0.850
120	1.45	240	1.025	360	0.839



365-μμf variable capacitor (Lafayette MS-214 or equivalent)
47-ohm 1/2-watt carbon resistor (10%)
2 x 3 3/4 x 6 1/4-inch bakelite case (Lafayette MS-216 or equivalent)
Front panel for case (Lafayette MS-217 or equivalent)
Binding posts (H. H. Smith, three 220R and two 220B)
Knob (Lafayette KN-32 or equivalent)
Clear celluloid for pointer

Fig. 6—Setup for calibration and measurement.

If you can get it in your budget, you can buy a vernier dial with a write-in scale. They're made by National, Millen, etc. Use the manufacturer's template when drilling dial mounting holes. Mount the capacitor on a bracket fastened to the panel.

Capacitor calibration

To calibrate the capacitor, use the arrangement shown in Fig. 6. Coil L is the 100-μh standard coil.

For each signal generator frequency setting, there is a particular capacitance that will produce resonance. Resonance is indicated by maximum deflection of the vtvm. If you substitute 100 μh for L in the formula $f_o = 1/(2\pi\sqrt{LC})$ and solve, you get $f_o = 15.9/\sqrt{C}$ where f_o (resonant frequency) is in megacycles and C is in micromicrofarads (picofarads). Table I was worked out from this formula and can be used to speed up calibration.

NOTE: Calibration accuracy is limited by the accuracy of the rf signal generator and the care you exercise during calibration. You can check the accuracy of your signal generator against radio stations of known frequency on a radio receiver.

Mark the calibration points with pencil dots just beyond the outer arc on the paper scale. Add the lines and lettering after calibration is complete.

Remove scale from the capacitor and fasten it on another piece of paper, and locate the scale arc center. Line up a straightedge on the center mark and the respective calibration marks to rule in the calibration indices. The index lines for 50-pf multiples and the end-of-travel values extend from the outer to the inner arc. The smaller division index lines extend from the outer to the middle mark. Identify the 100-pf multiples and end-of-travel values with numbers.

Refasten the scale to the panel. It's a good idea to provide a thin plastic protective cover. Use tape along each edge to hold the scale and cover in place. Install the panel in the case.

Calibration on broadcast stations

If you don't have a signal generator but live in an area with heavy broadcast coverage, you can use broadcast stations for calibration. They have the advantage of being accurate within a few cycles. The process is more tedious, of course. The arrangement is shown in Fig. 7. *Do not* connect an antenna, or your calibration will be inaccurate. Tune in the strongest station in your area. You know the frequency of the station and you can use Table I to determine the capacitance at that point. Then progress to other stations. You may have a problem identifying stations. If you use the recommended capacitor, you can use the calibrations on the original instrument for guidance. But don't try to copy them directly since there are small variations between units.

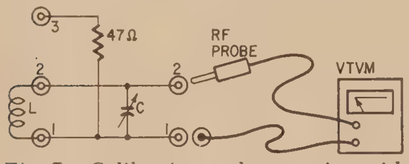


Fig. 7—Calibrating and measuring with a broadcast signal.

Measurements and use

This will be covered in detail next month. But as a starter, here's how to measure capacitance:

1. Connect instruments as in Fig. 6.
2. Turn the calibrated capacitor to the lowest readable capacitance value (C1) and connect the unknown capacitor across terminals 1 and 2.
3. Tune signal generator for resonance (f_o) as indicated by peak vtvm deflection.
4. Disconnect unknown capacitor and adjust calibrated capacitor for resonance. (If you can't obtain resonance, skip to step 6.) Call capacitor setting C2.
5. Then $C_x = C2 - C1$, where C_x is the unknown capacitance.
6. If you can't obtain resonance in step 4, use $f_o = 1/(2\pi\sqrt{LC})$ to compute C. Deduct C1 (Step 2) value from computed C to obtain unknown C_x.

TO BE CONTINUED

INVENTORS OF RADIO

Sir Oliver Joseph Lodge

By DEXTER S. BARTLETT

LODGE HAS BEEN CALLED "THE PATRON saint of radiotelegraphy." Through him, early experimenters got their first understanding of electrical resonance. He—not Branly—first used and named the coherer, and he sent wireless signals several hundred feet while demonstrating Hertz' discoveries.

Oliver Joseph Lodge was born at Penkull, England, June 12, 1851. He graduated D.Sc. from London University in 1877. In 1881 he took the chair of physics at University College in Liverpool, where he remained until, in 1900, he was chosen first principal of the new Birmingham University. He was knighted in 1902.

As far back as 1880, he was able to say, ". . . the transmission of such things as views and pictures by means of the electric wire . . . has not yet been done but seems already theoretically possible and may very soon be practically accomplished."

The phenomenon called cohesion—the sticking-together of small (metallic) particles in an electric field—dates back to 1850. It had been used sporadically from then on, but Lodge and a colleague used it in 1884 for a remarkably far-sighted purpose: clearing rooms of smoke and fumes!

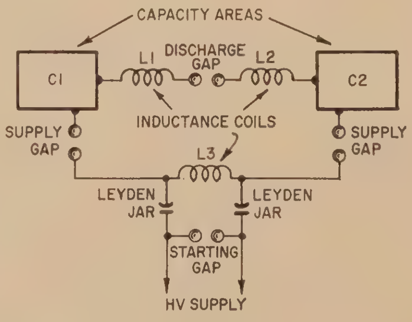
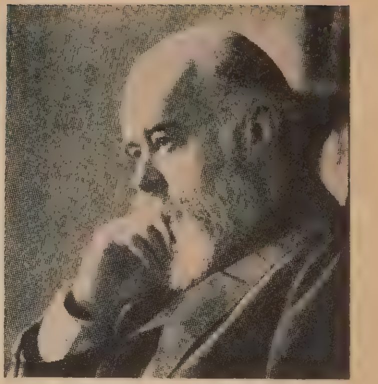


Fig. 1—A transmitter Lodge used around 1900. High voltage (from spark coil or Wimshurst machine) charges Leyden jars. According to Lodge, the spark across discharge gap is the most important in producing oscillating waves; however, discharge gap can be shorted and sparks across supply gaps used alone. In modern terms, C1–L1–L2–C2 form dipole antenna system with distinct resonant ("syntonous") frequency.



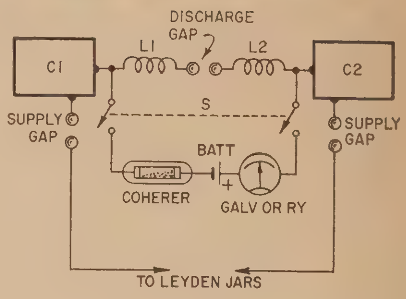


Fig. 2—One of Lodge's transmit-receive circuits. C1–L1–L2–C2 are same as in Fig. 1, and receiving circuit uses series-resonant voltage buildup across coils. S is a high-voltage cutout used to disconnect receiver during transmission.

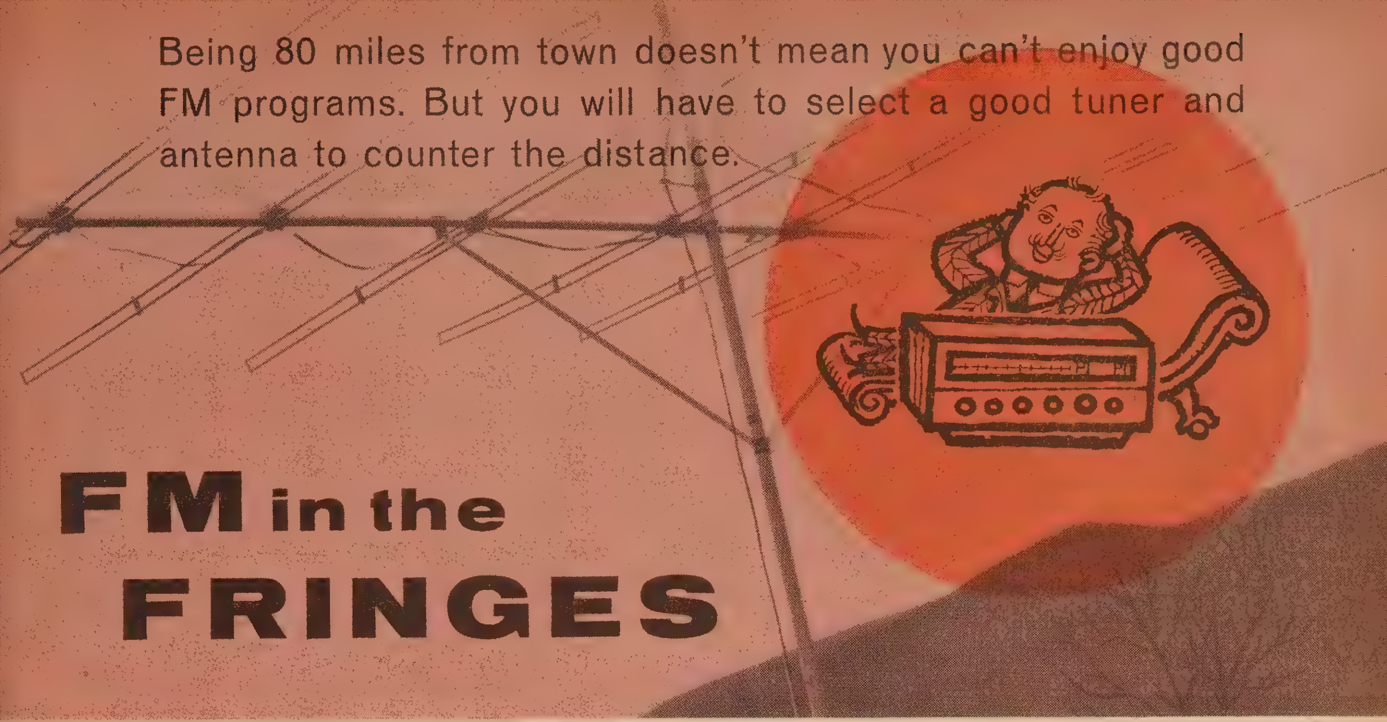
Branly was also working with the coherer, and in 1891 published among his findings the fact that metal filings in a glass tube would cohere for quite some time after the passage of an electric discharge, and remain conductive, but that they would separate and become nonconducting if the tube were tapped. It seems clear from his report that he did not realize that the phenomenon was caused by Hertzian (electromagnetic) waves. It was Lodge who grasped that fact and first put it to work.

Around 1897 Lodge turned his attention to wireless telegraphy. With a collaborator he took out the first patent on *tuned* wireless telegraphy, which was later sold to Marconi. It greatly increased the range of wireless communication, and for the first time allowed more than one station on the air simultaneously.

A brief list of some of his other work is almost breathtaking:

The seat of emf in a voltaic cell and the speed of ion movement; electrolysis; investigation of lightning (he proposed that it might be oscillatory in nature). Inventions include the disc coherer, automatic signaling machine, reed telegraph relay, portable antennas for military use, a triode detector circuit, and a method of cascading two triode amplifier stages.

He died at Amesbury, Wiltshire, England, on Aug. 22, 1940. END



Being 80 miles from town doesn't mean you can't enjoy good FM programs. But you will have to select a good tuner and antenna to counter the distance.

FM in the FRINGES

By JOSEPH MARSHALL

FM BROADCASTING HAS ENJOYED A PHENOMENAL resurgence in the past 2 years. The number of FM stations has increased by several hundred and the number of "good music" stations by several hundred percent. But thousands of refugees from TV living on the fringes of metropolitan areas or, like myself, out in the sticks, are getting only partial benefits from FM because they are either poorly equipped or unaware of what is available to them with good equipment.

By the same token, technicians and dealers are missing an opportunity by failing to cash in on the possibilities of fringe-area FM reception. Those who recall with pleasant nostalgia the good business enjoyed in supplying packages of receiver, tower, antenna, etc., for fringe-area reception in the early years of TV, would do well to take a look at the similar possibilities that exist today in FM.

There are few places in the eastern half of the US and on the southern Pacific coast where satisfactory reception of at least a half dozen FM stations is not possible. In many places, good equipment can bring an embarrassment of riches—scores of stations from different cities. Some of these are on the same or adjacent channels, with problems of preventing capture of wanted stations by unwanted ones. Possibilities are more limited in the wide open spaces of the West, but even here reception is usually possible from at least one city.

The problems of fringe-area FM reception are similar to those of TV. The first step in solving them is assessing the possibilities in any given area or neighborhood. Present reception provides good clues. It is probable that you can at least duplicate the best reception now enjoyed.

You can make a simple test to determine whether any present installation approaches the limit of performance the state of the art permits today. Tune to a point in the band where there is no trace of a station signal. Then short the antenna terminals while listening carefully to the noise and watching the tuning meter or indicator. If the noise increases or decreases, or the meter or indicator shows a difference in reading, the tuner already approaches the limit of usable sensitivity. If there is no change, the tuner is short of what is possible with current high-sensitivity tuners.

If a tuner does pass the test, check the antenna. There are FM antennas that can provide gains as high as 12 and 14 db. Therefore, if the antenna, as is very likely, provides only nominal gain it is easy to get an improvement of 6 db or even more with a better one.

If a location yields satisfactory TV reception, good reception of FM stations located in the same cities is practically a sure thing.

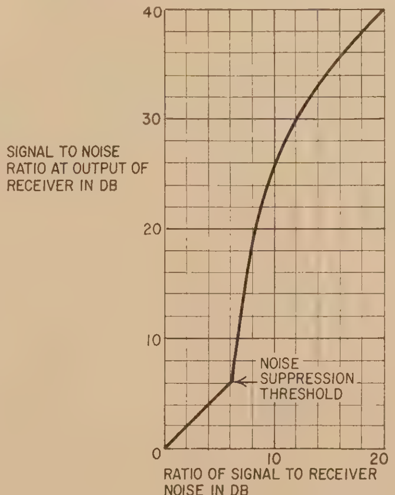
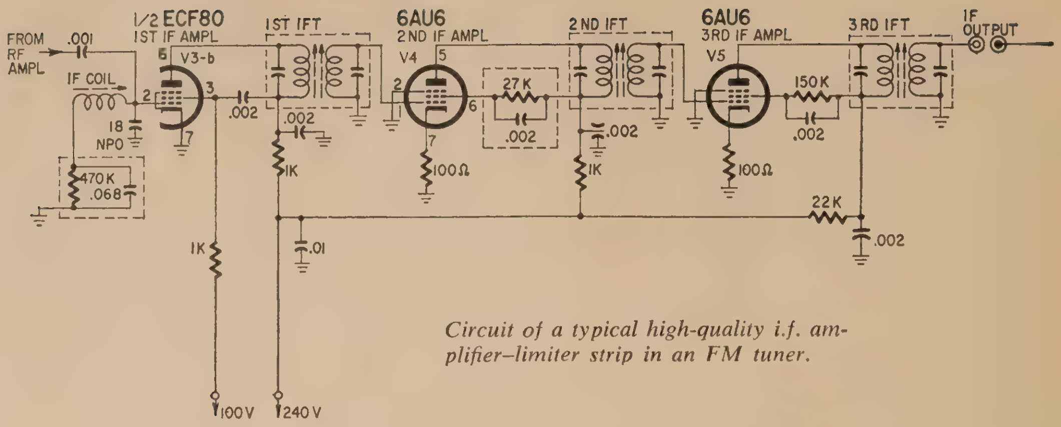


Fig. 1—For wide-band FM reception the signal must be about 6 db above receiver noise for noise suppression to begin. After that point the suppression curve rises rapidly and even a small reduction in receiver noise gives a great improvement in sensitivity.

Fringe-area tuners

The tuner, of course, is the key to satisfactory fringe-area reception. Fortunately, tuner sensitivity has been improved considerably in the past 2 or 3 years. Because of "threshold effect" this improvement may well make it possible to enjoy satisfactory reception with modern tuners in locations where it used to be marginal or unsatisfactory. The great advantage of FM is its ability to reduce the noise—to quiet it completely if the signal is strong enough. But there is a threshold that a signal has to cross before quieting can begin. It is established by the input noise of the first tube in the tuner. With the wide deviation used in FM broadcasting, a signal has to be about 6 db above receiver noise before quieting can begin. But in a good tuner, once this threshold is crossed, the improvement in signal-to-noise ratio can be extremely high. Note that in Fig. 1 there is little improvement when the signal is 6 db above the receiver noise. But when the signal increases to 8 db above the noise, the signal-to-noise ratio at the output is 20 db, an improvement of 14 db, and the ratio improves very rapidly with stronger signals.

Even a small improvement in the noise figure of a tuner can greatly improve the usable sensitivity. At the threshold level, lowering receiver noise (not the noise figure) as little as 1 db



Circuit of a typical high-quality i.f. amplifier–limiter strip in an FM tuner.

may well produce a 10-db improvement in signal-to-noise ratio at the output with the very same input signal.

Newer tubes and better design have produced tuners with usable sensitivity as much as 6 db better than was possible 2 or 3 years ago. The race for the best possible noise figure in tubes is currently between the nuvistor and frame-grid triodes. In circuits, it's between the cascode and the neutrode.

Tuner sensitivity is rated in several ways. The oldest and most flattering figure is in terms of the weakest signal into a 72-ohm input that will produce 20 db of quieting. This standard can yield sensitivities as good as 0.5 μv and better.

Unfortunately, several things about this measuring method make it a poor measure of performance. For one thing, all antennas covering the entire FM band are 300-ohm antennas. The same tuner will require at least twice the input signal to provide 20-db quieting with a 300-ohm input.

Furthermore, 20 db of quieting falls considerably short of providing *high-fidelity* reception. Finally, the quieting sensitivity is measured with an unmodulated signal and gives no hint of what happens to the modulation which, after all, is the thing we want to enjoy. A narrow-bandwidth tuner will almost always have better quieting sensitivity than a wide-bandwidth tuner. But if the bandwidth is so narrow that the signal sidebands cannot pass through it, distortion will be high and the signal, though audible, will not be tolerable. And a wide-band tuner with seemingly inferior quieting sensitivity may well deliver better overall quality on weak signals because of lower distortion, while a narrow-band receiver may make it possible to *log* very weak signals but will generate too much distortion for satisfactory *high fidelity*.

Theoretically, minimum distortion on very weak signals calls for a bandwidth in excess of 200 kc. As it happens, the *effective* bandwidth of an FM tuner varies with the signal strength. A very weak signal that just barely passes the limiting threshold in effect faces the narrowest portion of the response curve. This is true as indicated in Fig. 2, because in this case only the sidebands closer to the carrier benefit from limiting. Noise suppression may be satisfactory but distortion of the extreme sidebands will be high. On the other hand, a signal strong enough to poke its entire body above the limiting threshold looks in effect into the widest portion of the selectivity curve 6 db or more from the top. Thus, a tuner with a 150-kc bandwidth may produce high distortion on extremely weak signals but acceptable reception on slightly stronger signals. Obviously, if two tuners have the same quieting sensitivity, the one with the wider bandwidth will have better usable sensitivity on a modulated signal because it yields less distortion.

Fortunately, in the interests of simplifying the choice of a tuner, the IHFM standard of measuring sensitivity takes the bandwidth and the distortion it may produce into consideration. Under the IHFM standard, sensitivity is rated in terms of the weakest signal with 100% modulation that will produce, in the output of the tuner, no more than 3% noise plus distortion. This is a far more stringent and significant rating and guide to fringe-area performance. The tuner with 0.5-μv sensitivity for 20 db of quieting with a 72-ohm input may need from 2 to 5 μv to meet the IHFM standard with a 300-ohm input. Currently the best obtainable IHFM sensitivity with a 300-ohm input is around 1.5 μv and the average for highly sensitive tuners is between 2 and 3 μv. I would say that 4-μv IHFM sensitivity is the minimum for fringe areas.

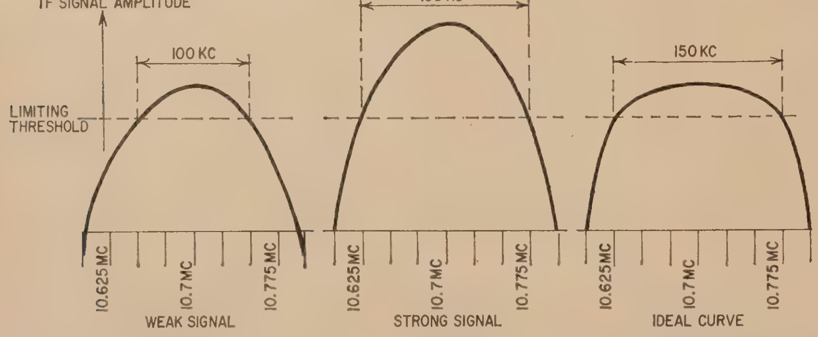
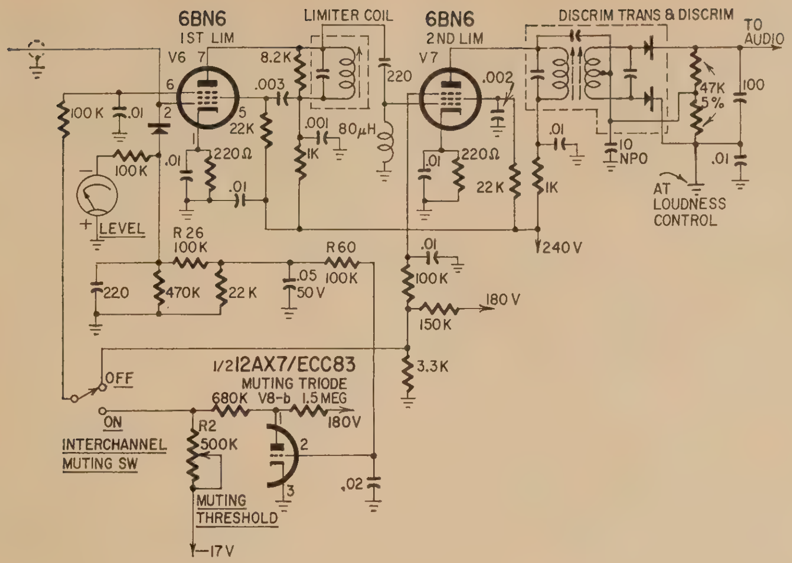


Fig. 2—A weak signal faces the narrowest portion of the receiver bandwidth. A strong signal, in effect, finds the bandwidth wider because of limiting action. For low distortion on weak signals bandwidth must be at least 150 kc at the very top of the response curve.

Limiters

Limiting should not only start on the weakest possible signal but, once the limiting threshold is crossed, the limiting should increase very steeply with every increase in signal strength until complete saturation is achieved. It should not take much more than 10 μv to produce complete limiting, and the quicker the tuner provides complete limiting, the better (Fig. 3).

Most fringe-area tuners will have two limiters with discriminator detectors and at least one with ratio detectors. The better ones will have two even with a ratio detector. In several current tuners, the i.f. amplifiers and limiters are arranged to give progressive amplification and limiting. Usually the second or final limiter will be circuited to limit all the time. The first limiter provides amplification on weak signals, and the i.f. amplifiers begin to limit in turn as the



signal increases.

Though with progressive limiting two i.f. stages and two limiters can provide high usable sensitivity, there may be a decided advantage in a tuner that uses three i.f. stages plus two limiters. Thus in a locality where one or more of the desired stations are on adjacent channels, it is practically essential to choose a tuner with at least three i.f. stages to get enough selectivity.

Another fine quality of FM reception is the ability of the tuner to suppress completely the weaker of two or more signals on the same channel, or, to put it another way, for the strongest signal to capture the tuner. This capture ability varies with different tuners and is expressed in a capture ratio. A figure of about 1.5 db is tops and anything under 6 db is very good.

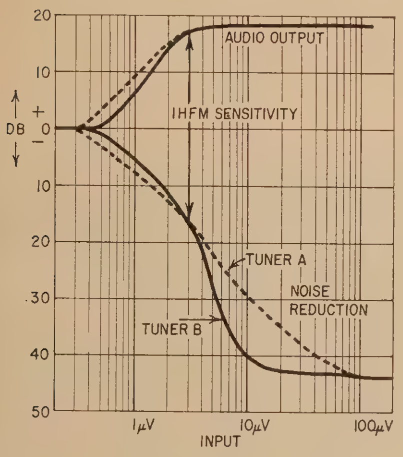


Fig. 3—Steep limiting curve essential for hi-fi reception of weak signals. Tuner A has more gain and gives traces of weaker signals than tuner B which has steeper limiting. Both have the same IHFM sensitivity, but tuner B is saturated with a 10-μv signal while tuner A needs 50 μv. Thus on all stations above 3 μv tuner B will produce less distortion and noise and therefore better fidelity.

Capture ratio can be extremely important in the fringe areas. A good capture ratio will not only prevent audible co-channel interference but, in combination with a rotatable antenna with a good front-to-side or front-to-back ratio, may make it possible to receive two or more stations on the same channel. A good capture ratio together with good selectivity also favors reception of stations on adjacent channels.

Oscillator stability is also important. The afc should be capable of being disabled or adjusted. Even with afc, oscillator stability should be very good. In many ways a tuner without afc is preferable because it implies that the oscillator stability is inherently good. Also, a tuner without afc is certain to have a very wide-band detector which favors a good capture ratio, low distortion on weak signals, and easy tuning. Furthermore, a wide-band detector is usually free of "three-point tuning" (Fig. 4). With narrow-band detectors there is enough response at the two outer skirts of the response curve to obscure and often to make impossible the reception of weak signals on channels adjacent to strong ones.

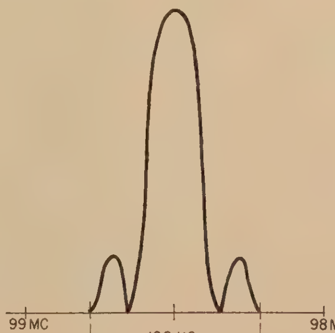


Fig. 4—Narrow-band detectors yield three-point tuning—the major peak at resonance and lesser peaks on each side. These "side responses" can obscure or suppress weak adjacent-channel stations.

Another important characteristic for weak-signal reception is the absence of oscillator "pulling". An oscillator that pulls has the same effect as afc on adjacent weak signals. If, with the afc disabled, stations tend to pop or snap into resonance—very much as if the afc were on—the tuner is definitely guilty of pulling. But if even a very strong station has to be tuned carefully to resonance, it is relatively free of pulling.

Antenna arrays

There is no substitute for a good antenna, and the best tuner will profit from being fed the fattest possible signal by the antenna. Yet many people, though using a 10-element TV array, still use a folded dipole or a turnstile for FM reception.

FM antennas have been covered ("Stereo FM Antenna Has High Gain and Quality,"March 1963); we will concentrate on general considerations and ways and means of utilizing a given antenna most effectively.

To begin with, it is always worthwhile to try to use a high-gain TV antenna for FM reception. If the TV antenna won't work—or if it still leaves some FM stations of only marginal worth—choose a suitable FM antenna. Get one with at least 5 elements and preferably 10. It doesn't pay to skimp here. The difference in cost between a 5- and a 10-element job will be small compared to total cost of the installation and even the finest tuner will profit from the fatter signal.

In most fringe locations, the antenna should be rotatable. You can expect to receive FM stations from several directions even if now you receive TV stations from only one. Furthermore, a rotatable antenna will greatly assist reception of stations on adjacent or the same channel, and minimize multipath distortion.

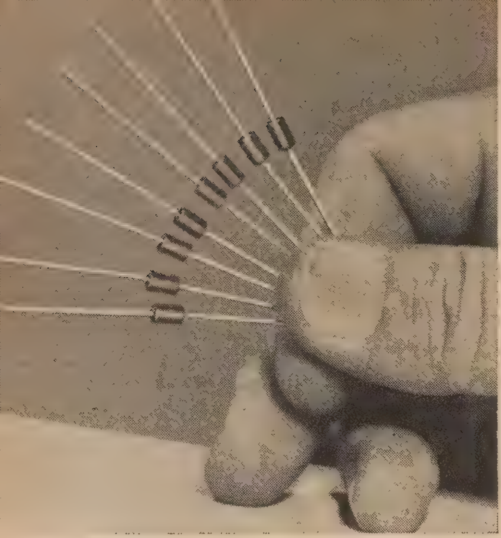
Boosters

Boosters may or may not help, depending on the tuner. They are broadband devices and seldom give as good a noise figure as a tuner using the same tube and circuitry. The new boosters use frame-grid tubes in cascode or neutrode configurations. These improve the absolute sensitivity of many older tuners. And, though they may not improve the noise figure of the new tuners, they may improve reception by increasing the gain of the system and thereby the degree of noise suppression, through improved limiting. END

replace them with silicons!

Smaller, cooler and longer lasting than any other rectifiers, these will save you money.

BY JAMES D. McCALL*



Specifically intended for "entertainment product" replacement, these low-cost "Surmetic" silicon diodes from Motorola can carry 1 amp and have a piv of 400.

Hardly in the TV-replacement category, these stud-mount silicons can handle up to 250 amps continuous, with surges up to 4,500 amps over 1 cycle!

VACUUM-TUBE RECTIFTERS BURN OUT and lose emission. Selenium deteriorates with age. Silicon rectifiers don't. Properly installed, a silicon rectifier is more reliable than any other type. A job stays repaired. Fewer callbacks, greater customer good-will.

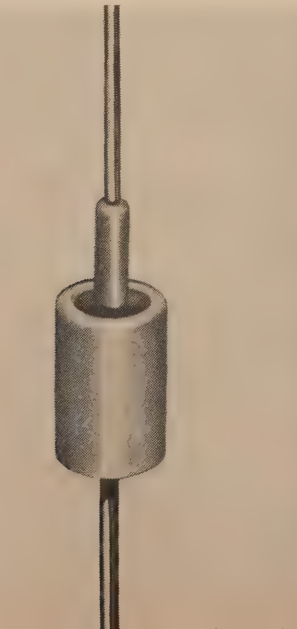
Lower inventory is another advantage. A silicon rectifier can be an almost universal replacement for any application. A single type (the 1N1695, for example) can replace a full line of 65-, 150-, 200-, 300-, and 400-ma seleniums and many vacuum-tube rectifiers. Silicons can be installed easily in even the tightest locations. Their high current ratings at relatively high temperatures reduce heat-sink requirements. By stocking a few silicon units, you can save many costly callbacks where replacements are not available.

Silicon rectifiers outperform seleniums, and do a better job than germanium ones, which have a slightly lower forward-voltage drop but higher leakage currents and lower operating temperature ratings. With silicon rectifiers, therefore, you can get a higher B-plus voltage for a brighter TV picture and greater undistorted audio in cases where the receiver stages are not already operating at their maximum rated power. Fig. 1 compares the voltage drop and reverse current rating of silicon, selenium and 5U4-G rectifiers.

Selecting the proper rectifier

While a single silicon rectifier could be selected to replace virtually any rectifier encountered in consumer product equipment, there is a good reason for stocking at least two or three types: economics. The cost of a rectifier increases with current and peak-inverse-voltage rating, and there's little to gain by using a high-current high-voltage rectifier where a lower-cost unit will do the job. An understanding of silicon rectifier characteristics will help you select the proper replacement units.

Current Rating. Silicon rectifiers, like all semiconductor devices, must be *current derated* as temperature rises beyond the normal. (Fig. 2). The derating curve for a typical unit rated 600 ma at 45°C (113°F) shows that the unit can be used to supply only 250 ma at 100°C. This is simply because a semiconductor device, used without an external heat sink, must dissipate the heat



Typical of inexpensive, all-purpose silicon rectifiers is this little job rated to carry 1 ampere.

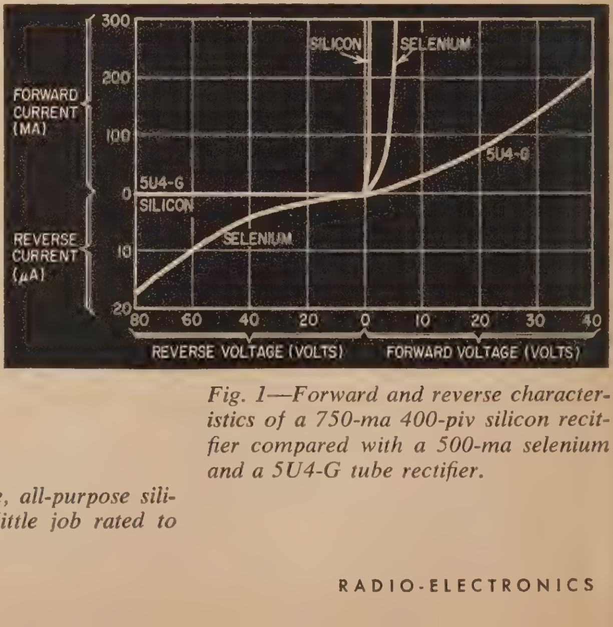


Fig. 1—Forward and reverse characteristics of a 750-ma 400-piv silicon recitfier compared with a 500-ma selenium and a 5U4-G tube rectifier.

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*Applications engineer, Motorola Semiconductor Products Div.

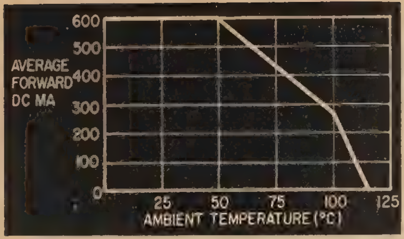

Fig. 2—Current derating graph shows how current capacity decreases as temperature goes up.

due to its internal power loss directly through its case, while still keeping the junction temperature at a safe value.

The small package of a silicon rectifier is possible because it has lower loss compared to selenium and tube rectifiers. The package itself, in normal applications, will dissipate well enough. An ambient temperature of 100°C, for example, corresponds to 212°F—far above normal chassis temperature. And when a silicon unit replaces other types of rectifiers, especially tube types, the temperature around the rectifier is further reduced by the lower power loss in the silicon device so that a practical limit of 80°C (176°F) can safely be assumed for all but very unusual applications.

Voltage Rating. Just as important as the current rating of a rectifier is its peak-inverse-voltage (piv) rating. If too much reverse (or inverse—same thing) voltage is applied between the rectifier terminals, the unit will be permanently damaged.

The required piv rating depends on the power supply circuit. In a half-wave, capacitor-input supply (Fig. 3) the rectifier, at worst (with the load open-circuited), is subjected to a piv twice the peak input voltage. In such circuits the rectifier piv rating must be at least twice the peak, or 2.82 times the rms voltage applied to the rectifier input. In areas where the line voltage is often higher than normal, be sure to take that into account. In special applications with extremely high piv's, you can series-connect two or more lower-piv diodes.

In full-wave, capacitor-input circuits (Fig. 4), each rectifier must again have a piv rating of twice the peak, or 2.82 times the rms voltage of half the transformer secondary.

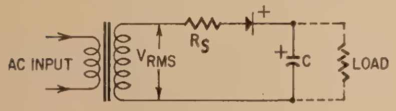

Fig. 3—Typical half-wave rectifier circuit.

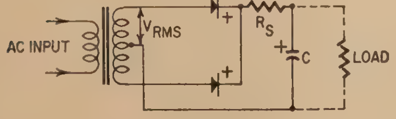

Fig. 4—Typical full-wave rectifier circuit.

In full-wave bridge circuits (Fig. 5), each rectifier must have a piv rating of at least the peak value (1.41 rms) of the voltage across the transformer secondary.

For both full-wave and bridge circuits, the average current through each rectifier is only *half* the total load current, and the rectifier current rating may be chosen accordingly.

With power supplies using choke-input filters, piv ratings are somewhat relaxed under normal operating conditions. Yet during initial warmup, piv can approach capacitor-input values. For maximum reliability, therefore, better use the same piv ratings as with capacitor-input filters.

When you connect two or more rectifiers in series to handle unusually high piv's, shunt each one in the series string with a 100,000-ohm to 1-megohm resistor. This helps distribute the peak inverse voltage across the series string more equally among the rectifiers. Two rectifiers in series will carry the same current, but in general-purpose silicons, back-resistance is not carefully controlled. The inverse voltage will thus depend on the back resistance; the higher-resistance diode will hold back more than its share and may fail sooner. Once it shorts, the other is sure to follow, since the full piv is now across it. Shunting the diodes with resistors helps prevent this trouble.

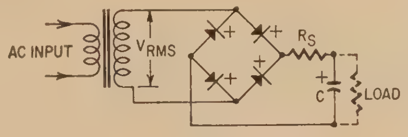

Fig. 5—Full-wave bridge rectifier.

Surge Currents. With capacitor-input power supplies, surge currents can be tremendous if there is little series resistance in the circuit. (This is the current that charges the filter through the rectifier when the equipment is first turned on.) If the capacitor is fully discharged at turn-on, it is a virtual short circuit across the output of the rectifier until it becomes charged during the first quarter-cycle of the applied voltage.

With vacuum-tube rectifiers, the forward resistance of the tube is usually great enough to limit the surge current to a safe level. With selenium rectifiers (lower forward resistance), a series surge-limiting resistor (R_S in Figs. 3, 4 and 5) is almost always used. When either of these rectifiers is replaced with a silicon unit, the surge current will be much larger because of the very low forward resistance of silicon diodes. **A surge-limiting resistor is vital unless the transformer winding resistance alone is high enough to keep the current within the surge-current rating of the rectifier.**

The total resistance value required can be calculated from the equation

$$R_S = \frac{V_P}{I_S \text{ rating of rectifier}},$$

where R_S is the required value of limiting resistor, I_S the surge current, and V_P the peak voltage.

If the measured dc resistance of the transformer secondary, plus that of any existing surge-limiting resistor, equals or exceeds the calculated value, no circuit modifications are required. If the calculated value is higher, any existing resistor must be increased to equal or exceed that value. The minimum power rating of the surge-limiting resistor can be determined from the formula $P = 2I^2R$ where P = resistor power rating (including a 2-to-1 safety factor), and I = the average output dc of the supply.

Because of the lower forward voltage drop of silicon rectifiers, (even including a surge-limiting resistor), the dc output voltage of the power supply will normally be higher than in the original circuit using tube or selenium rectifiers. This increased output voltage often improves circuit performance. Where the circuit is already operating at maximum voltages, however, the surge-limiting resistor—or the value of any filter resistor in the power supply—will have to be increased to reduce the voltage to its original level. Watch filter-capacitor ratings, especially.

Surge-limiting resistors are needed only in capacitor-input filter supplies. The inductor in choke-input filters limits the surge current to safe levels.

Vacuum-tube rectifiers used in series-heater arrangements can be replaced with silicon rectifiers if you complete the series-heater string through a suitable dropping resistor. The additional resistor can be wired across the heater terminals of the now-unused rectifier tube socket. The resistance value and power rating of the resistor can be calculated by checking the heater voltage and current rating of the tube and applying the standard Ohm's Law formulas ($R = E/I$ and $P = EI$).

Since the resistor will drop somewhat more voltage during the initial warmup period, its power rating should be at least twice the calculated value to provide an adequate safety factor.

Installing silicon rectifiers

Silicon rectifiers come in a variety of standard packages. Probably the most useful for replacement purposes is the package with pigtail leads on the ends of the rectifier. Such units can be installed easily on printed-circuit boards or wired to tube socket terminals or ter-

TABLE

Current Rating (Resistive Load) ma	PIV (Volts)	Type Number
750	300	1N539, 1N2612
750	400	1N540, 1N2613, N1169*
750	500	1N1095, 1N2614
750	600	1N1096, 1N2615
750	800	1N2616
750	1,000	1N2617
600	300	1N1694
600	400	1N1695
600	500	1N1696
600	600	1N1697

*At 25° C.

minal strips in conventionally wired sets.

Tube rectifier replacement is usually the simplest. All you have to do is remove the old rectifier tube and wire the silicon rectifier to the socket terminals corresponding to the plate and cathode pins of the tube.

Replacing a selenium rectifier sometimes presents a problem because taking out the defective unit also removes the connecting points for the rectifier leads. It's relatively simple, however, to remove these wires and connect a silicon rectifier directly to the terminals to which they were connected.

Observe polarity when you install the replacement unit! Also, mount the silicon rectifier away from heat radiators, such as high-power resistors.

Practical replacements

The table shows representative silicon rectifier types ideally suited for replacements in radios and TV sets. Current and piv ratings are listed for each unit, and additional technical data can be obtained from manufacturers' data sheets.

There is just one additional point to keep in mind when evaluating data-sheet information. The data usually apply to resistive or inductive loads. When used with capacitive loads, the rectifier must be current-derated. (Remember the high *peak* currents in such loads.) When maximum output currents for capacitive loads are not specified in the data sheet, a rule-of-thumb is to derate to two-thirds the maximum resistive load current for reliable operation.

Things to keep in mind

Used within its ratings, there's no rectifier more reliable and versatile than a silicon. You can use them in industrial equipment, broadcast transmitters —anything.

If you're a service technician, you might consider carrying a few silicon rectifiers of different commonly met ratings in your tube caddy, along with an assortment of low-value 1-watt resistors silicon rectifier away from heat radia-as surge limiters. With these, a few voltage checks and a little common sense, you can replace tube and selenium rectifiers with silicons on house calls—especially nice if you're working on a set with persistent rectifier failure.

But there are a few things to watch. First, it's wise to use a piv rating about 30% higher than the measured and calculated value, especially in sets with short rectifier life. Could be high line voltage, could be circuit transients —so play it safe! Another trick in sets with repeated rectifier trouble (ones with power transformers) is to bridge a 100- to 500-pf 1,000-volt ceramic capacitor across the transformer secondary to provide a low-impedance path for high-voltage spikes. Such a capacitor can often help in transformerless supplies—connect it from the rectifier anode to B-minus.

Remember that net B-plus will be greater with a silicon rectifier than with other types. This is a two-faced feature —it can bring increased performance . . . or rapid callbacks! If the set's components are already running near their maximum ratings, think twice before slipping in a silicon rectifier, unless you're prepared to make other changes, like increasing the value of series surge or filter resistors to bring the voltage back to its original value. END

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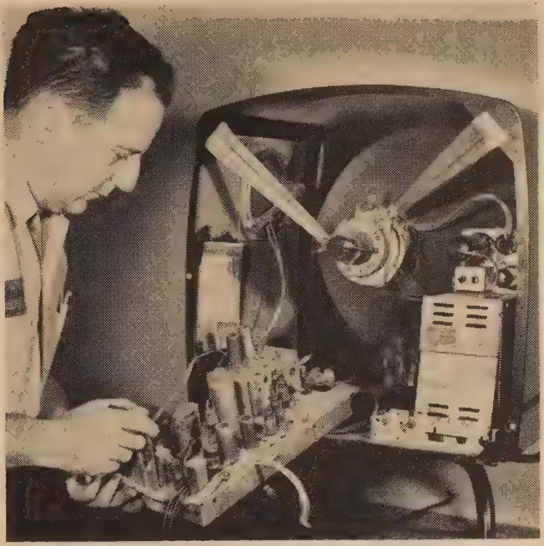
SEPTEMBER ISSUE
(on sale August 15th)

TV Tuners Fix or Trade?



Try and fix them first . . .

Here are some hints on how to do it.

By ART MARGOLIS

WHEN A TV TUNER REPAIR FACES YOU on the bench you either dig in and repair it or remove the rf unit from the chassis and trade it in on a rebuilt. The approach you use depends on the complexity of the repair, your tuner repair skills and equipment, the cost of the trade-in and how close the distributor is to your shop.

Some shops trade in a large percentage, others only a few of the tuners they handle. The tack you take depends largely on the tuner trouble. From analysis of the symptoms you decide whether the repair is electronic or mechanical, easy or hard.

Whether we trade or not, we go through some routine procedures. We make sure the tuner is the source of trouble. We isolate the defective tuner section and estimate the time needed to complete the repair.

Isolation

Talking to some of the factory rebuilders, I learned that a lot of tuners they take on trades need no repairing at all. In other words, the trouble wasn't in the tuner to start with. So the first step is to be sure the tuner is at fault.

A lot of "tuner trouble" symptoms confusingly have other possible sources. *Snow* will occasionally be caused by the antenna, i.f. or agc circuits. *Ghosts* can also originate in the antenna, i.f. and video circuits. *Loss* of or *overloaded audio* and *video* can be i.f., video, agc or audio output troubles. *Hum bars* can originate in any circuit. *Sync* troubles can of course be in the sync circuits in addition to tuner.

So, before attacking a tuner, we isolate the trouble and make sure it is in the tuner. This is relatively easy if you have a flying-spot scanner. You can substitute an i.f. input containing a test pattern for the tuner output. The i.f. signal is injected into the grid of the first i.f. amplifier. If a good test pattern appears on the screen, the tuner is at fault. If the TV screen still shows the same trouble, the tuner is exonerated.

Without a flying-spot scanner, isolation is a bit more difficult. Take your rf signal generator and set it to the i.f. of the TV. Modulate the rf with the generator's signal note, usually 400 cycles.

Inject this signal into the grid of the first i.f. amplifier. If a screenful of hum bars appears on the picture-tube face, where the trouble was before, the tuner is at fault (Fig. 1). If the trouble is still around, it's somewhere after the first i.f. grid.

Electronic troubleshooting

Once the trouble is pinned down to the tuner, we determine whether it is electronic or mechanical.

If it's electronic, we almost always decide not to trade but repair.

The tuner is an electronic unit in itself. Its circuits are more critical than other TV circuits. Slight movement of leads, resistors and capacitors greatly affects distributed capacitance and inductance effects. To offset this, as little movement of components as possible is desired. This means making your tests outside the tuner barrels and locating the offending part without extensive probing of tube sockets and wafer switches.

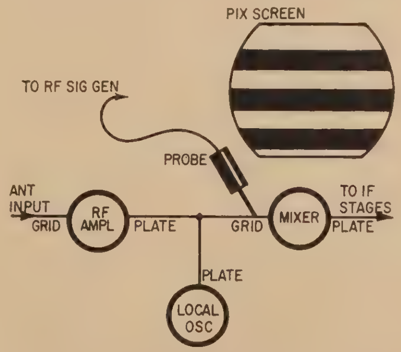


Fig. 1—Injecting a modulated rf signal at the grids of the first i.f., mixer and r.f. amplifier grids puts visible hum bars on the TV screen.

This is done with the aid of tube-socket pin adapters and the schematic of the TV.

An adapter is inserted between the mixer tube socket and the tube. (Of course, the tubes are tested first and proven good.) Then with the schematic laid out in front of you, find the mixer.

Set the signal generator at 55.25 mc and modulate it with the 400-cycle note. The TV should already be set on channel 2. Inject the signal into the mixer grid. If sound bars appear on the screen, the trouble precedes the mixer grid. If the trouble is between the mixer grid and the first i.f., weak sound bars or no sound bars will appear.

Repeat the procedure with the rf amplifier grid. If the trouble is between the rf grid and the mixer grid, the sound bars will be affected adversely. If the trouble precedes the rf grid, the sound bars will show up perfectly.

This procedure will isolate the area of trouble. Once this is determined, resistance and voltage checks of the indicated stage are made to pinpoint the actual part.

One good example was a 24-inch Motorola that had no sound or picture, but a good raster.

An rf signal was injected into the first i.f. and the sound bars appeared. The tuner was definitely at fault. We inserted a tube socket adapter into the 5U8 oscillator-mixer tube socket, and touched the signal generator probe to the mixer grid. Sound bars did not appear on the screen.

I pulled over the vtvm and began

reading voltages. Mixer plate voltage was low. Instead of 160 volts, there was only about 40.

I checked the grid bias. Instead of −2 as it was supposed to read, it was +20. No wonder the plate voltage dropped! The tube was conducting very heavily.

Turning off the TV, I examined the schematic carefully. Where could that +20 be coming from? There was a 10-pf coupling capacitor between the mixer grid and the rf plate (Fig. 2). I circled it on the schematic.

Then I gingerly opened the tuner cage and looked for the capacitor. It was hidden behind two resistors and a myriad of wires. It was only a tiny thing to begin with. Before touching anything I wanted to be sure it was the culprit.

I got another tube socket adapter and plugged it into the rf amplifier socket. Then I made a resistance reading between the rf plate and mixer grid the capacitor was coupling. I read 1200 ohms. I examined the schematic. Taking all the shunt resistances into consideration, it should have read about a megohm. Looked like the capacitor was at fault.

I took my tiny dikes and snipped one end of the capacitor, leaving some lead sticking out of both the capacitor and the tube socket pin at the mixer grid. Then I attached the vtvm probe to the rf plate. With a needle-nose probe I touched the open end of the capacitor. Good! 1200 ohms. It had shorted.

Note, the only cutting so far was the one snip of the capacitor. Nothing else had been touched. All readings were made outside the tuner barrel.

I snipped the other end of the capacitor, again leaving some lead sticking out of the connection point in the barrel. Then with my soldering aid I twisted the excess leads, each into a hook.

The replacement capacitor leads were also twisted into a hook. Then the replacement was hooked onto the old twisted leads. It hung there as close to the position of the old one as possible.

A thin-nose soldering iron put a ball of solder at each point. The new replacement was firmly in place. The TV came on like new. Sound and picture were still in perfect alignment since little had been touched.

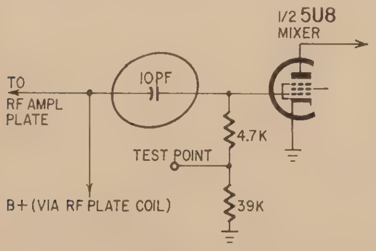


Fig. 2—The 10-pf coupling capacitor had shorted and put 20 volts on the mixer grid.

Mechanical repairs

If the trouble is mechanical, a physical checkup is in order. The tuner barrel spins many miles during the course of a year, wearing out contacts, plastic shafts, etc. The worn parts cause loss of picture and sound. To restore the picture they must be replaced or repaired.

It's best to retire a really beat tuner by trading it in. However, they are in the minority. Most mechanical faults can be easily fixed. All you need to know is how to do it.

Space limitations will not permit me to examine and explain all tuners and all mechanical repairs, just as I can't go into a great number of electronic repairs. However, here are the two commonest. Maybe after doing them, you'll be able to figure out other jobs you've been trading in.

Both troubles cause the same symptoms, intermittent loss of sound and picture. You'll discover trouble No. 1 in tuners in late model Philcos.

During production the tuner's wafers are installed and soldered in by hand. Great care is used to solder with the least amount of heat possible, yet make each joint good.

As a result, the rosin flows heavily with the solder. The joint holds good. That is during the first year of service. Then the rosin begins to get between the contact point and the solder. Yes a good old-fashioned rosin joint.

When you get a tuner that develops intermittent channels, this could be the trouble. If you're lucky enough to have the intermittent acting up for you, leave the TV on during the repair. If not, you can turn the TV off.

Methodically touch every solder joint in the tuner with a hot iron till the solder flows well. If the TV is on, when you hit the bad ones the channel will snap back on. If the TV is off, your cure will not be as sure. As an extra bonus, while you are going tediously from contact to contact, you might hit a couple that never had any solder to start with.

While not very dramatic, this particular repair accounts for many trade-ins, according to distributors.

The second common trouble you are familiar with, but not as sure of the repair. It's common to lots of Magnavoxes and Admirals. Some of the Sarkes Tarzian's fall prey to this one too, plus others.

The symptoms: You must jiggle the tuner to get the channel to stay on. This is similar to the routine cleaning trouble symptoms, but cleaning doesn't help.

You'll find that rotating the tuner in one direction loses the channels. Yet when you rotate the tuner in the other direction the channels return, but will not hold.

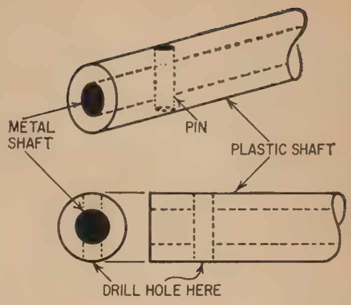


Fig. 3—When the plastic shaft slips over the metal one, drill a small hole through both shafts and insert a pin to lock them together.

What's happening can be observed if you remove the tuner from the chassis and observe the center shafts. The core of the shaft is metal. The shaft around the core is plastic. The plastic shaft is attached to the drum.

The metal and plastic shafts are supposed to be welded together tightly and move as one shaft. As you rotate the tuner, you see the shafts are no longer welded together and the plastic shaft slips as you rotate the metal core shaft which extends out to the channel selector knob. The repair? You must weld the two shafts back together again. How?

First, line up the plastic and metal shafts to the alignment that makes good contact and produces good pictures on all channels.

Then take a ¼-inch drill with a tiny bit. Drill a hole at a convenient location through the two shafts, starting on one side of the plastic, through the metal core dead center, then out the other side of the plastic (Fig. 3).

Take a piece of nail or any other form of pin and tamp it into the hole, being sure that it holds tight. With this supporting bar in place, the two shafts have no alternative but to rotate together as they did when new. If you master this technique, you'll really reduce trade-ins.

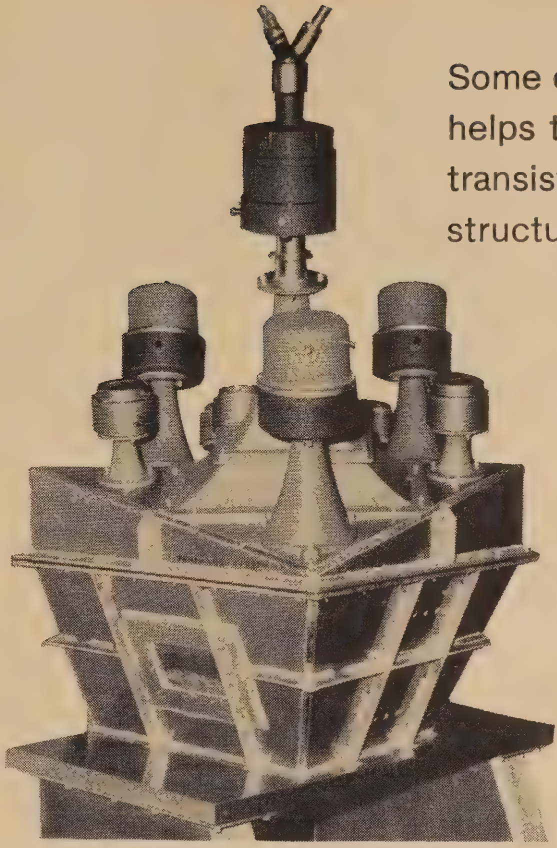
To sum up, use a routine procedure when you examine a suspect tuner. First step, make sure the tuner is at fault. Next, isolate the defective tuner section. Then, determine whether the repair should be continued or a trade-in deal made.

Electronic repairs can usually be repaired on the spot. Serious mechanical breakdowns are best traded in. Not-so-serious mechanical breakdowns, if you develop the techniques, can be repaired on the bench. The main point, to a busy businesslike TV technician—is it cheaper to fix or trade? The least expensive procedure is the one you should use. END

BIG NOISE

By **WILLIAM F. KERNIN**

Some of the world's highest fi helps to test everything from transistors to steel panels for structural weakness.



A small reverberation chamber with its variety of drivers.

WITH THE MASSIVE MISSILES AND boosters that carry our space gear aloft the noise levels can be terrific. The designer of electronic gear for guidance, communications and the multitude of intricate activities necessary must consider this noise environment, test his components for it and develop "noise-proof" systems. To simulate this ambient noise, the acoustics laboratory is used.

Noise test sources

High-level noise can be produced in two ways—mechanically, as with sirens and whistles, or electronically. As electronics technicians, let's look at the second method.

At Bell Aerosystems Co. we use a basic system of electronics for generating noise fields. One typical channel is shown in the block diagram (Fig. 1). For a source of sound or noise, we have a choice. An audio oscillator gives us single, discrete frequencies, handy for finding resonant conditions in components. Or we can use a piece of gear known as a random-noise generator, that produces all frequencies in a given range—say from 20 cycles to 20 kc—with no definite repeatability characteristics. This is the most versatile source. Combined with variable electronic filters to be discussed later, almost any noise environment can be simulated.

Then we can use an external source to drive the system. A most practical source of this type has been the tape recorder or the tape loop, particularly in reproducing rocket noise.

From our source we proceed to the electronic filter bank. Each filter allows us to accentuate or attenuate a given frequency or band of frequencies to produce a composite signal that simulates the actual sound the part under test will see. If the distribution of frequencies in the original noise field is unknown, the filters can be adjusted for a standard random-noise spectrum.

From the filters, the individual signals go to mixers where they are combined to form a composite noise signal. We are concerned with three types of composite—low-, medium-, and high-frequency bands. A separate electronics "chain" is required for each of the three bands.

From the mixers, each type of composite signal goes to its group of preamps. The basic preamp is a low-noise, wide-band amplifier with a variable gain control and metering circuit to measure how much signal it is feeding to its power amplifier. Each power amplifier in turn drives its own speaker.

Thus, using the various filter and gain controls, the sound product from a given speaker can be pretty well tailored.

Monitoring

Fig. 2 shows in block form a basic monitoring and measuring system. Mainly, microphones designed to handle high-level sound are used, such as the Massa M-141. The outputs from these microphones are fed to General Radio sound-level meters and analyzers where overall and individual band sound levels are monitored and recorded. For long microphone extension lines, a high-impedance-input amplifier—cathode-follower system boosts the signal-to-noise ratio. Outputs are also provided for tape recording these microphone signals for future analysis.

The microphones are usually located in the test chamber so that one monitors the sound field being created

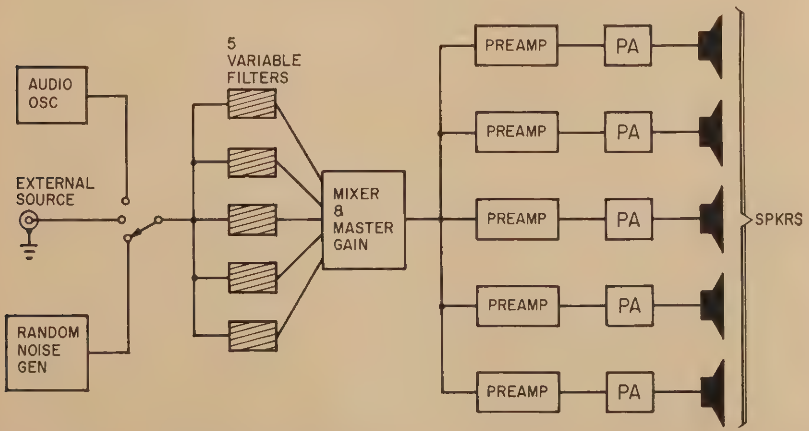
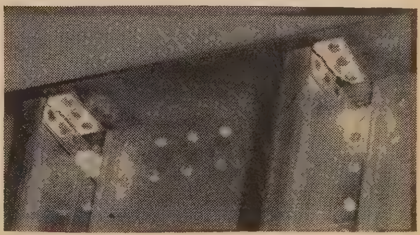


Fig. 1—Basic "chain" of devices used to create or reproduce a noise field for testing components.



Cracked struts on a test panel subjected to a high-level noise field.

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* Instrumentation technician, Bell Aerosystems Co.

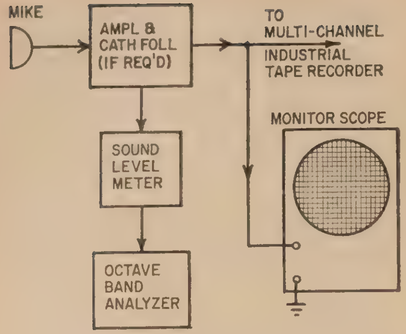

MIKE
AMPL & CATH FOLL (IF REQ'D)
TO MULTI-CHANNEL INDUSTRIAL TAPE RECORDER
MONITOR SCOPE
SOUND LEVEL METER
OCTAVE BAND ANALYZER

Fig. 2—Noise monitoring and measuring system. Recorder permits preserving information for later analysis.

by the speakers and one or more monitor the sound pressure levels at given locations near the part under test. The photograph of one of our large electronic consoles will give you some idea of the equipment used for a typical chamber.

A fairly straightforward system of electronics, isn't it? But it presents some impressive engineering problems.

Let's look at some of the electronics used. Fig. 3 shows the circuitry for the power amplifiers used in our consoles. Although rated at 150 watts, they are used at the 50-watt level most of the time. The 150-watt rating gives us a margin of power for handling peaks and transients.

The output circuit is based on the Dynaco A-450 transformer with four 6CA7's (EL34's) in push-pull parallel. An efficient printed-circuit voltage amplifier and phase inverter drives these output tubes.

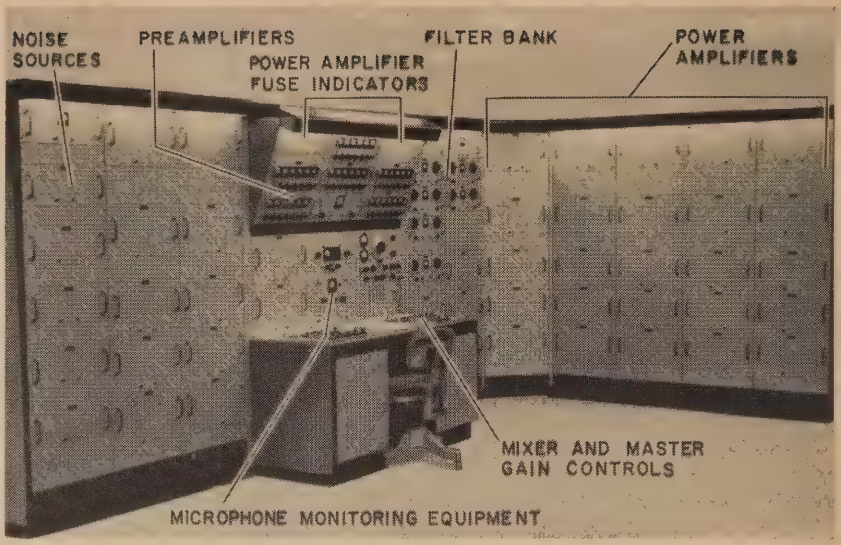
An interesting feature of the power amplifier: to protect the output tubes, their common cathodes are fused with a ½-ampere fuse. If the tubes are overdriven or "take off" on their own, the fuse blows instead of the tubes. To show that the fuse is gone, an NE-51 neon bulb located on a central control panel and two resistors (R15, R16) are used. As long as the fuse is OK, the NE-51 connected across it stays out; when the fuse goes, the bulb lights up.

The preamplifiers are based on the circuit of Fig. 4. A low-noise 12AY7 is used in a moderate-gain, low-hum, low-noise circuit. Gain is controlled by a 10-turn potentiometer R1. R2 eliminates any sudden surges through the speakers if the arm of the potentiometer should ride over a rough spot or break contact intermittently. A cathode-follower stage drives a monitor meter and the power amplifier with no loading effect on the preamplifier.

Commercial electronic filters and random-noise generators are used for the rest of the electronics "chain".

Test chambers

At present, Bell Aerosystems Co. uses four basic types. The tuned tube is perhaps the simplest example of the first type—the resonant chamber. As can be seen in Fig. 5 and the photograph, an ordinary PA driver is mounted in one end of a long tube. From the other end, a snug-fitting piston is inserted with the test component mounted on it. The microphone monitors the intensity of the sound field created in the


NOISE SOURCES
PREAMPLIFIERS
POWER AMPLIFIER FUSE INDICATORS
FILTER BANK
POWER AMPLIFIERS
MIXER AND MASTER GAIN CONTROLS
MICROPHONE MONITORING EQUIPMENT

Electronics control and monitor console for large test chamber.

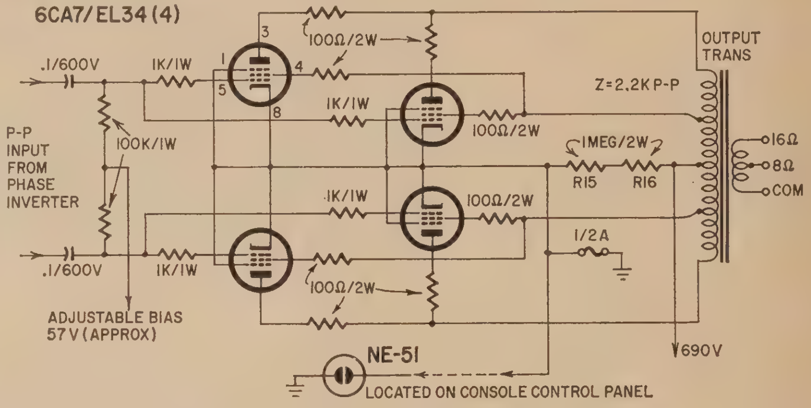

6CA7/EL34 (4)
.1/600V
1K/1W
P-P INPUT FROM PHASE INVERTER
100K/1W
ADJUSTABLE BIAS 57V (APPROX)
100Ω/2W
1K/1W
1
3
4
5
8
OUTPUT TRANS
Z=2.2K P-P
1MEG/2W
R15
R16
16Ω
8Ω
COM
1/2A
690V
NE-51
LOCATED ON CONSOLE CONTROL PANEL

Fig. 3—Output stage of 150-watt amplifier used in noise testing.

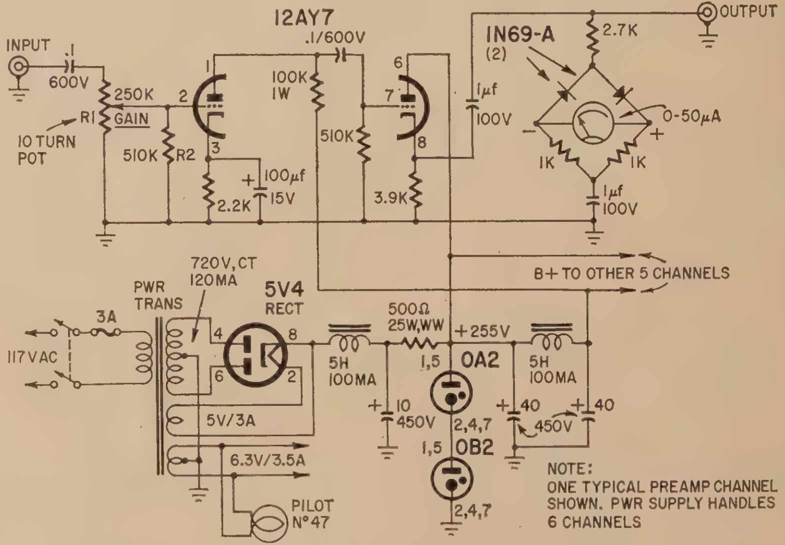
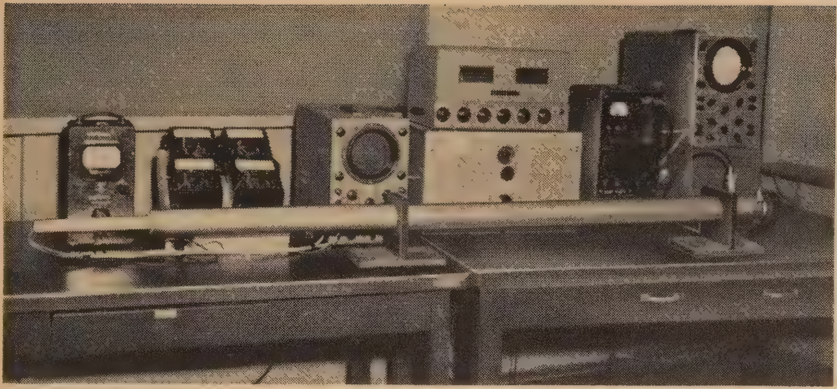

INPUT
.1 600V
250K GAIN
R1
10 TURN POT
12AY7
1
2
3
6
7
8
510K
R2
2.2K
100μf 15V
.1/600V
100K 1W
510K
3.9K
1μf 100V
OUTPUT
IN69-A (2)
2.7K
0-50μA
1K
1K
1μf 100V
B+ TO OTHER 5 CHANNELS
3A
117VAC
PWR TRANS
720V, CT 120MA
5V4 RECT
4
8
6
2
5V/3A
6.3V/3.5A
PILOT N°47
5H 100MA
10 450V
500Ω 25W,WW
+255V
1,5
OA2
2,4,7
OB2
5H 100MA
40
450V
40
NOTE: ONE TYPICAL PREAMP CHANNEL SHOWN. PWR SUPPLY HANDLES 6 CHANNELS

Fig. 4—Preamplifier–cathode-follower circuit, with metering.



"Tuned-tube" setup described in the article. Equipment is ready for a typical test.

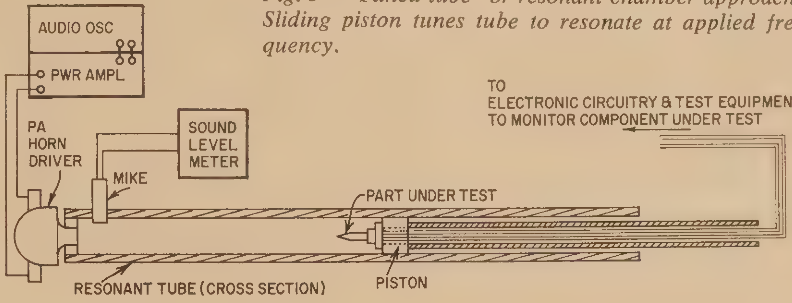
tube. The driver is driven by a power amplifier at a desired frequncy and the piston is moved in and out of the tube until the microphone gives a maximum indication. When this condition is reached, the tube is tuned for the input frequency—like a tuned organ pipe in reverse. This system is good for specific discrete frequencies and can be used to best advantage in testing electron tubes, relays, transistors and other electronic parts to determine their points of resonance or weakness.

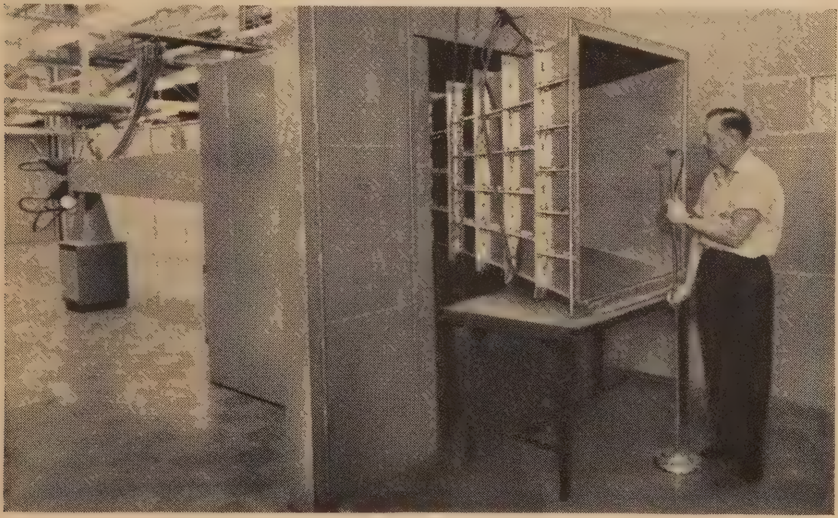
The second type is called a reverberation chamber. This, in simplest form, is a box built so that no two sides are parallel or perpendicular. Hence, reflections of sound waves off the walls produce a diffused sound field within the enclosure. The photo at the head of this article shows a small version.

This type of chamber is driven with a multitude of speakers (woofers, squawkers and tweeters, in hi-fi parlance) fed with random-noise or a recorded ambient-noise program through the electronics system previously described. The sound field produced in this chamber more nearly represents the actual noise conditions seen by components. Here we can test individual electronics parts, whole assemblies, modules, structural panels—even partial airframes. If you don't think noise can be powerful, take a look at the photograph showing the cracked struts on a metal test panel that was subjected to a high-level noise field.

The speakers used with the chamber are usually high-efficiency, high-power drivers—especially for the medium- and high-frequency ranges. Woofer cone speakers were used originally for the lows. Recently, we have had better results with what is known as a "modulated air" driver. Simply stated, air under pressure is fed into the driver case. The amount that passes out the front is determined by a signal-driven "gate" corresponding to a speaker voice coil with a vane that widens or narrows the aperture through which the air passes. This effectively modulates the air with the low-frequency signals. High-level, low-frequency noise can be generated with a surprisingly small amount of electrical driving power.

Fig. 5—"Tuned-tube" or resonant chamber approach. Sliding piston tunes tube to resonate at applied frequency.


AUDIO OSC
PWR AMPL
PA HORN DRIVER
SOUND LEVEL METER
MIKE
TO ELECTRONIC CIRCUITRY & TEST EQUIPMENT TO MONITOR COMPONENT UNDER TEST
PART UNDER TEST
RESONANT TUBE (CROSS SECTION)
PISTON



Checking out the low-frequency horn used to drive a large reverberation chamber.

The other two types of test chambers are the plane-wave and progressive-wave. They are driven by a system of speakers and electronics similar to that used for the large reverberation chambers.

Earlier we mentioned the industrial tape recorder and tape loop as a source of signals. They are best used in this way: Suppose, during the test firing of a rocket engine, a relay subjected to the tremendous noise fields started to act up. Before we go any further, we've got to retest that relay and wring it out to correct its difficulties. But you can't run a rocket engine at many thousands of dollars a run just to check a $20 relay. So, we do the next best thing—record a rocket run on tape for ambient noise, acceleration, vibration, etc. Then, back in the acoustic laboratory, we can put the relay in the chamber, set up the system and drive the electronics from the recorded tape for an accurate reproduction at true levels of the rocket run. If a certain portion of the run seems to cause trouble, and we want to repeat it, we transfer it from the original tape to the tape loop. Then we can play it through the system as long as necessary to test the relay in every conceivable way.

Servicing

Servicing such a laboratory from the electronics technician's viewpoint is like handling a bunch of high-power hi-fi systems all at once.

Thus, almost all service problems are those familiar to any industrial electronics technician who has experience in repairing test equipment and public address facilities.

So you can see that noise, besides being a nuisance, can cause a lot of trouble. Now that industry is aware of what sound can do, acoustical testing is growing rapidly. And the versatility of electronics goes hand in hand with the field of acoustics. Perhaps someday your job as an industrial electronics technician may be to keep a system like this going strong. END

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 154 West 14th Street, New York 11, N.Y.

By Jack Darr

Service clinic

LAST MONTH WE TALKED ABOUT ADJUSTable horizontal linearity control in flyback circuits. Now, let's go into the types you'll find in later models; we could call these "fixed-tuned" circuits. There is "control" of horizontal linearity, of course; there must be control to keep plate current within limits and to get good horizontal linearity in the picture. It's built-in by the design engineer. He takes advantage of better modern parts and designs the circuit so that horizontal linearity is good *if* all the parts are OK!

This gives us the same old problem in a different way. Adjustable linearity controls cover up "mistakes", small mismatches, etc. Now, we're out of luck in that department! We say that all parts are fixed, but this isn't literally true. We *can* make adjustments by varying part values when replacing, or by changing the size of existing parts. Now, we've found a way to get into trouble and we're happy. These circuits demand *exact* replacements. While we do have the standard tolerance of about 10%, we'll be better off if we don't use it. When making replacements, let's use either factory replacement parts, or *exact* electrical duplicates.

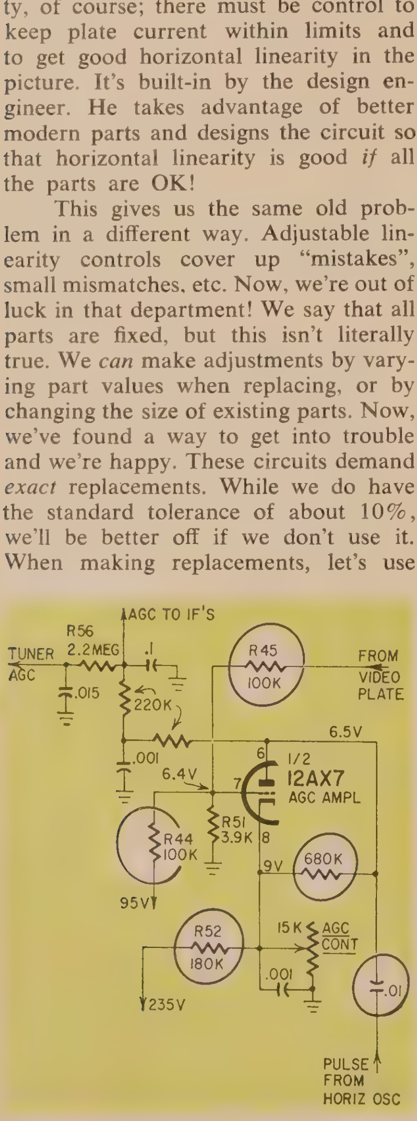


Fig. 1—Agc amplifier circuitry in Zenith 19M20. Any of the circled components could cause drift if defective.

How? Well, we *match*—yokes to flybacks, and vice versa. Because of the tuning of our secondary circuit, we have to. The *inductance* of the parts is the standard we'll use. For example, a yoke might have these specs: 20 mh horizontal and 43 mh vertical inductance, with a 21ALP4 CRT. This is all we need.

Transformer catalogs give these values. This could be a Triad Y-41, a Merit MDF-92, Stancor DY-35A a Thordarson Y-16, etc. Looking up the make and model of the TV set in these catalogs, we'd find this yoke listed as an exact replacement. We add the correct value of capacitor across the horizontal windings, and we're home free. By the way, you *did* spot the other important clue I gave, didn't you? The *deflection angle* of the yoke! Tube book says that a 21ALP4 is a *90° tube*. This is important, of course.

Flybacks, same way. Easiest way is to look up the set in one of the transformer catalogues, if you don't have the schematic or service data for it. *Don't* make the mistake of using the *dc resistance* of the windings; this has very little to do with it. If you'll check "identical" transformers in different makes, you may find variations in resistance, but never in inductance!

What's this got to do with horizontal linearity? Good question. The linearity is determined by the *tuning* of the secondary circuit. In any resonant (tuned) circuit, the tuning is determined by the inductance and capacitance; right? So, since our capacitance is fixed, specified in the schematic, in the number and size of fixed capacitors used, and so on, we must match the original inductance to get back the original linearity. We do this by choosing an *exact duplicate* flyback or yoke, and connecting it in the same way. After this, if we do not have good linearity, we can look for something else in the circuit. Our inductive parts will have the right amount of "self-capacitance". If a given unit is listed in the catalogue as an exact replacement, it will be. These helpful gentlemen have made exhaustive tests in their own labs to be sure.

Reworking Yagi antenna

Is it possible to convert a single channel-3 Yagi into a combination channel 6 and channel 3, by adding another dipole for channel 6 and altering size and spacing of the directors? I would like to know how to do this.—A. M., Redway, Calif.

Confidentially, so would the antenna design engineers! Achieving satisfactory bandwidth is one of the biggest headaches in modern antenna design. The engineers have done miracles in the latest models of all-channel Yagi antennas. I'm afraid that it would be very difficult to rework an existing antenna in the way you mention, and the results would be far from satisfactory. Your best bet would be to replace the single-channel Yagi with any one of the better modern all-channel types.

Zenith 19M20 agc drift

I've got agc drift in a 19M20 Zenith as the set warms up. I can adjust the agc control for a perfect picture, then when the set warms up, out she goes.—S. A., Norco, La.

One of three things is the cause: a 12AX7 tube with severe grid emission, a resistor drifting with heat as the set warms up, or a slight leakage in a coupling capacitor (Fig. 1). Incidentally, there is an error in some early Sams schematics on this chassis. R56 should be 2.2 megohms instead of 22 megohms shown. This is the tuner agc delay resistor.

Check the resistors in the voltage supply circuits: R44 and R52, also R45. These are very critical, since a change in value of any of them can cause a drastic shift in operating voltages on the tube. Leakage in the coupling capacitors can also give trouble.

TV with 2 pictures

I get a double picture, vertically, in a Bendix 3033. By lifting the .05-μf capacitor from the vertical oscillator plate. I can control the picture with my vertical hold. Checked all resistors and capacitors. What's the matter?—S. J. G., Philadelphia, Pa.

Your vertical oscillator is running too slow: 30 cycles instead of 60, since you get *two* complete pictures. You said that you had checked all the ca-

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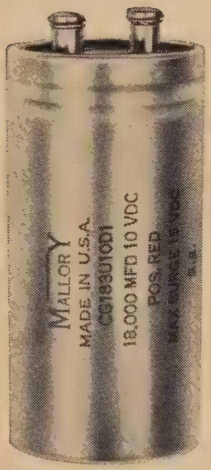

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You may be occasionally confronted with the problem of finding a lot of capacitance. Maybe for a sound system where you want to squeeze the last bit of ripple out of a power supply. Or for brute-force filtering of low voltage, as in a DC supply for filament circuits.

If your first inclination is to round up a bunch of duals, triples and quads until they add up to the microfarads you need, then hook them in parallel—for the sake of your budget, resist the temptation and read the rest of our tip. For you can get a lot of capacitance in a single unit, at considerably lower cost, by using a Mallory Type CG Computer Grade Capacitor.

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pacitors and resistors, but I believe you must have missed one!

Since you can get a picture by lifting the sync input, you probably have a leaky capacitor somewhere in the vertical integrator or coupler. Leaky capacitors anywhere in the oscillator, or resistors which have increased in value, will make the oscillator run slow by increasing the time constants. Check the capacitors in the integrator, the sync coupling capacitor, and the resistors in the grid circuit.

Flyback overheats

I'm repairing an RCA KCS-68B. This set burned up a flyback transformer; I replaced it, and inside of 2 weeks it burned out, too. The core gets too hot to touch, and the 1B3-GT flashes over at the base. There is a continuous hissing sound from the corona discharge around the flyback. I've changed everything I can think of, including tubes, the high-voltage capacitor, etc., and I've still got overheating.—W. P. Y., Massillon, Ohio.

I can very distinctly remember going through the same thing, about 5 years ago, on this same chassis! I sympathize with you!

Your basic trouble is saturation of the core, causing the overheating. So, first, run a *complete* adjustment procedure on the horizontal output, as specified in the service data.

(1) Set the width link in the middle position, shorting out upper and middle connections; this is minimum width. (2) Set width control to the maximum counterclockwise position. (3) Adjust the horizontal drive control counterclockwise until an overdrive line appears, then back off until it disappears. (4) Connect a 0–500-ma meter in series with the 6CD6 cathode, and adjust the horizontal linearity control for minimum plate current; this must not be more than 115 ma. (5) Set the width control until the picture just fills the screen.

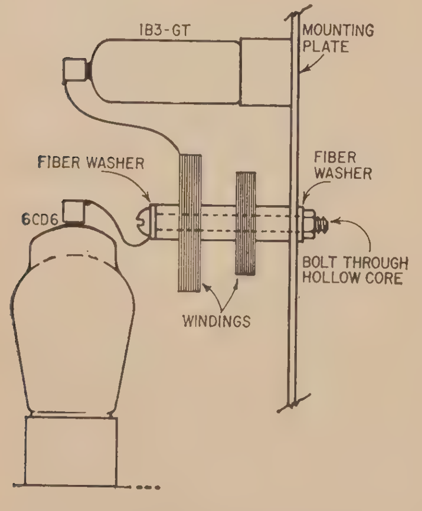

Fig. 2—Metal washers on mounting bolt act as shorted turns, overloading the flyback transformer.

It may be that you will get overheating after finishing these adjustments. If so, connect a 20–30-pf capacitor, not less than 6 kv, between terminal 2 on the flyback and the "start" end of the width control. This is the end *not* connected to the WIDTH switch.

Last, take a close look at that flyback (Fig. 2). See if this is the type which has a brass bolt all the way through the core, with metal washers at each end. If it is, take the bolt out, throw the metal washers away, and replace them with heavy fiber washers. The original configuration on some of these flybacks made this come out as the most beautiful shorted turn you ever saw! This caused the flyback to draw excessive current and overheat.

Calibration error

I have a little printed-circuit Japanese FM radio, and the dial calibration is off about 4 mc. The top trimmers on the tuning gang aren't connected. What would you advise?—J. C., Jim Thorpe, Pa.

Check the calibration with a signal generator or FM station as near to one end of the band as you can get. Set the dial pointed exactly on this frequency, then go to the other end and adjust the trimmers.

Incidentally, if the top trimmers are not connected, look on the bottom of the tuning gang: there may be another set there. This was common in the Old Days! Also, you may find variable inductors or separate trimmers on the coils.

Slow foldover

This one has me—it's a Silvertone 528 47700 TV. Plays fine for 5 minutes, then starts folding slowly from the right. Picture goes out, raster keeps getting dimmer and finally goes out.—J. O., Baton Rouge, La.

Since this trouble shows up in the *right* half of the raster, it's most likely to be in the horizontal output tube. Check the 6AV5 for grid leakage or, better still, replace it. Also, monitor the grid drive waveform *and* negative grid voltage while it's acting up. Leakage in the coupling capacitor or a change in grid resistor value could be the cause.

Also, check the screen grid voltage of the 6AV5 "before and after." Since you say the sound goes at the same time, try pulling the sound output tube. Leakage in the coupling capacitor could be loading the B-plus to the point where it is causing this trouble.

Resistance vs impedance

I want to replace the 3.2-ohm speaker on my TV set with a 16-ohm unit, in a separate cabinet. The schematic (Fig. 3) gives the load resistance of the output transformer as 300 ohms. I can't find an output transformer to match this! Can you tell me where to find one?—A. McA., Houston, Tex.

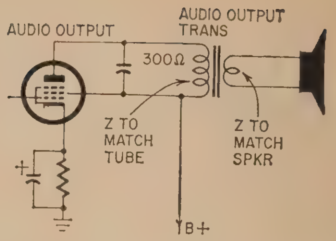

Fig. 3—Resistance figure next to output transformer is dc resistance, for troubleshooting—not load impedance.

You're being led up the garden path! The figure given on the schematic next to the output transformer is the dc resistance of the primary winding! This is for quick-checking of the transformer only.

To match any output tube to any voice coil, look up the plate load *impedance* in a tube manual. G-E calls it "load for rated power output, ohms" RCA lists it as "load resistance (sic)" Output transformer ratings are given in terms of this value: a transformer will be labeled "10,000-ohm plate to 8-ohm vc," etc. Many transformer makers list the actual power output tubes, so, "6AQ5 plate to 4-ohm vc," and so on. You can use either one, and come out the same way.

BC-CB auto-radio antennas

I have just installed a combination broadcast–Citizens band antenna on a car. Now, the BC radio doesn't have nearly as much output as it did before! CB radio works O.K. Antenna is one of the top-loaded whips. Lead-in about same length as before, but no results on BC.—W. B., Washington, D. C.

The impedance matching (for want of a better word) on auto radio antennas is very critical. The poor radio designer has to make his set work on a midget whip about 30 inches long, through all kinds of troubles. So, he makes his front end resonant with the

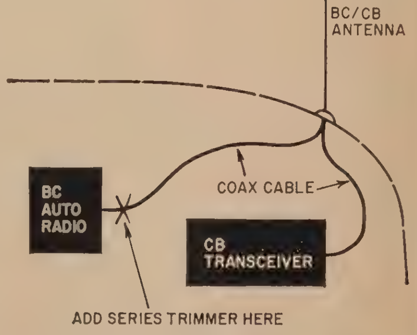

Fig. 4—Install trimmer as shown to help match impedances.

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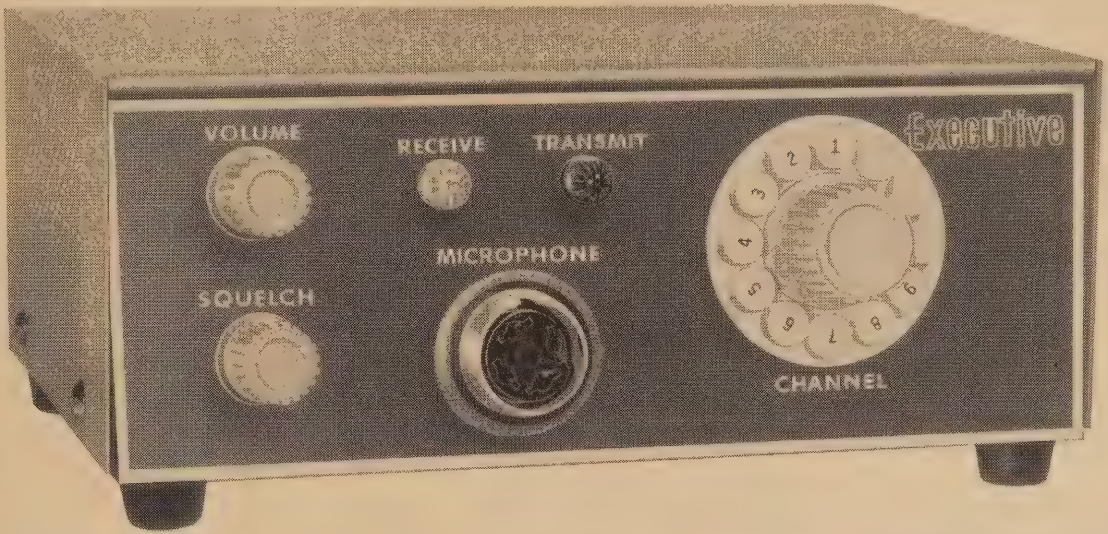

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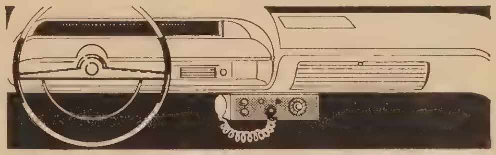

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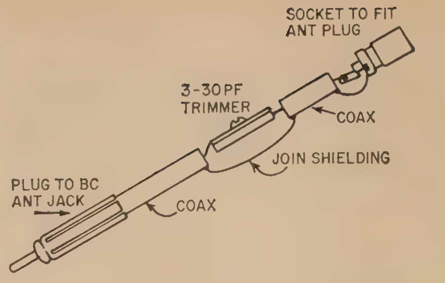


Fig. 5—Simple test-adapter for trying series-capacitor matching approach.

capacitance and inductance of that antenna. By "tuning" the entire rf circuit, *including* the antenna, and using high-Q circuits, he gets an amazing amount of efficiency.

Now, this antenna obviously does not match. So, try matching it. From the fact that it is top-loaded, I'd say that you could match it by connecting a series trimmer capacitor into the BC radio lead-in (Fig. 4), and adjusting this, plus the radio's regular antenna trimmer, for maximum volume. If you run out of capacitance before you find a peak, connect a small fixed capacitor in parallel with the trimmer. Use something like a 3- to 30-pf trimmer. This can be hooked into a tester consisting of a plug, socket and short piece of coax or wire (Fig. 5). Under some circumstances, it could even be mounted inside the radio cabinet.

Drifting horizontal sync

An RCA 140-P-020 portable plays fine for about 20-30 minutes, then goes out of horizontal sync. Snap it off and on again and sometimes it comes back, sometimes not. Changed the 6CG7. No help.—H. S., Chelsea, Mass.

This looks like a drifting resistor. It will be somewhere in the time-constant circuits in the horizontal oscillator. Cool the set off, turn it on, and apply heat to each resistor that could possibly have anything to do with the horizontal oscillator frequency—grid resistors, plate resistors, cathode resistor, etc.

Fig. 6 shows some good prospects. Also check the 330-pf coupling capacitor between the frequency coil and the pin 7 grid.

Du Mont RA-106 agc

In a Dumont RA-106 TV, I can't get any sound or picture; raster is lit up. If I pull the 6AT6 agc tube, I get sound and a dim, washed-out picture. Can you advise?—W. H., Huntingdon Valley, Pa.

Most likely cause, agc trouble. To verify this, override the agc bias with a bias box or a battery and variable resistor. Put about 1–2 volts negative on the agc bus. If this brings back pictures and sound, check all resistors is the agc circuit, definitely including all plate, grid and cathode resistors in the agc tube circuits.

In sets of this age, you're apt to find "cumulative drift"—that is, several resistors each drifted slightly off value, instead of one resistor far off. So be sure to check all resistors used in this circuit, and replace any that are more than 10% off.

Interference in CBS 22C38

I replaced the horizontal afc control coil and some resistors, also the 12BH7 tube, in a CBS 22C38. Now I have light and dark bars on the screen. Do you suppose this interference comes from the horizontal section, and if so, why?—G. C., Independence, Iowa

Quite possibly. Check the appearance of the bars. If the scanning lines on the raster are *straight* but vary in brightness (or thickness), this is rf pickup from the horizontal sweep stage into the rf amplifier. If the scanning lines bend at the points where the bars show up, then it is caused by yoke ringing.

To get rid of this interference, try shielding the yoke leads. Wrap metal foil around them, and ground each end of the foil by winding bare wire all the way around the cable. You may have to use a piece of shielded 300-ohm ribbon between the tuner and antenna terminals. Quick check for this: pull the rf amplifier tube from the tuner. If the bars go away, it's radiated interference. END

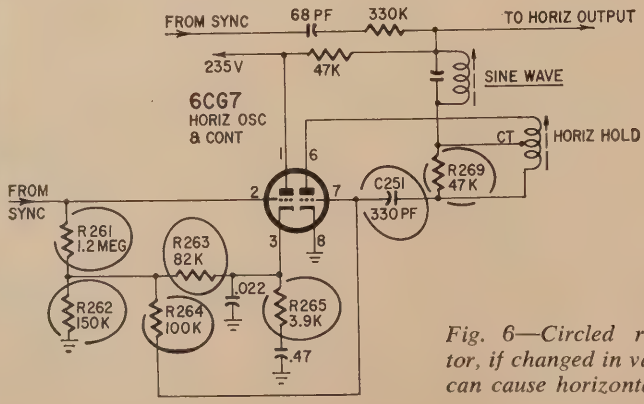
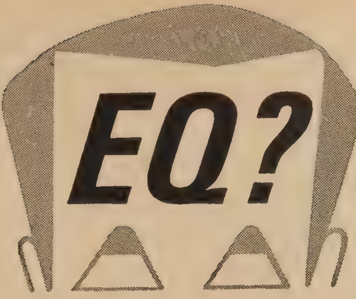


Fig. 6—Circled resistors and capacitor, if changed in value or heat sensitive, can cause horizontal drift.

WHAT'S YOUR EQ?



These are the answers.
Puzzles are on page 43.

Voltage Divider?

After charging current stops, the voltage across the resistors must be in proportion to the resistors. Thus there will be 270 volts across the 90,000-ohm resistor, and 30 volts across the 10,000-ohm resistor. Therefore, if the voltage across C2 equals x, that across C1 must equal $300 - x$, and across C3, $x - 30$.

Since charging current for C2 and C3 is drawn from C1, $Q1 = Q2 + Q3$. Q is charge, and $Q = CV$.

Therefore: $1 \times (300 - x) = 2\,(x) + 3 \times (x - 30)$

Remove parentheses: $300 - x = 2x + 3x - 90$, $6x = 390$, and $x = 65$.

Therefore, voltage on $C1 = 235$, voltage on $C2 = 65$, and voltage on $C3 = 35$.

L-pad Puzzler

With no load across terminals 1 and 2, an ohmmeter across 3 and 4 will read just 2R—the two equal resistors in series. When we connect 150 ohms between terminals 1 and 2, we shunt one of the two equal resistors, and the total resistance "seen" now from 3 and 4 is

$$R + \frac{150R}{150 + R} = 300 \text{ ohms}$$

Just following the rules of algebra, we can solve the R very easily by putting both terms on the left of the equals sign over a common denominator, $150 + R$:

$$\frac{(150 + R)R + 150R}{150 + R} = 300$$

When we simplify and remove the parentheses, we get

$$\frac{150R + R^2 + 150R}{150 + R} = 300$$

Now multiply both sides by $150 + R$, to get rid of the denominator:

$$R^2 + 300R = 45{,}000 + 300R$$

We can throw out the term 300R, since it appears with the same sign on both sides of the equals sign. That leaves just $R^2 = 45{,}000$, or $R = 212.5$ ohms.

Fussy Fuses

The 6-amp through 10-amp fuses are large enough that their current-carrying capacity does not determine the maximum current of the circuit and are used only to make the reader think. Each fuse in parallel will carry the same amount of current, since each fuse offers no practical resistance to current flow. Therefore, if the circuit carries more than 5 amps of current, the 1-amp fuse will blow. More than 8 amps will blow the 2-amp fuse, and more than 9 amps will blow the 3-amp fuse, after which the 4-amp and the 5-amp fuses will blow.

So the combination carries 9 amps.

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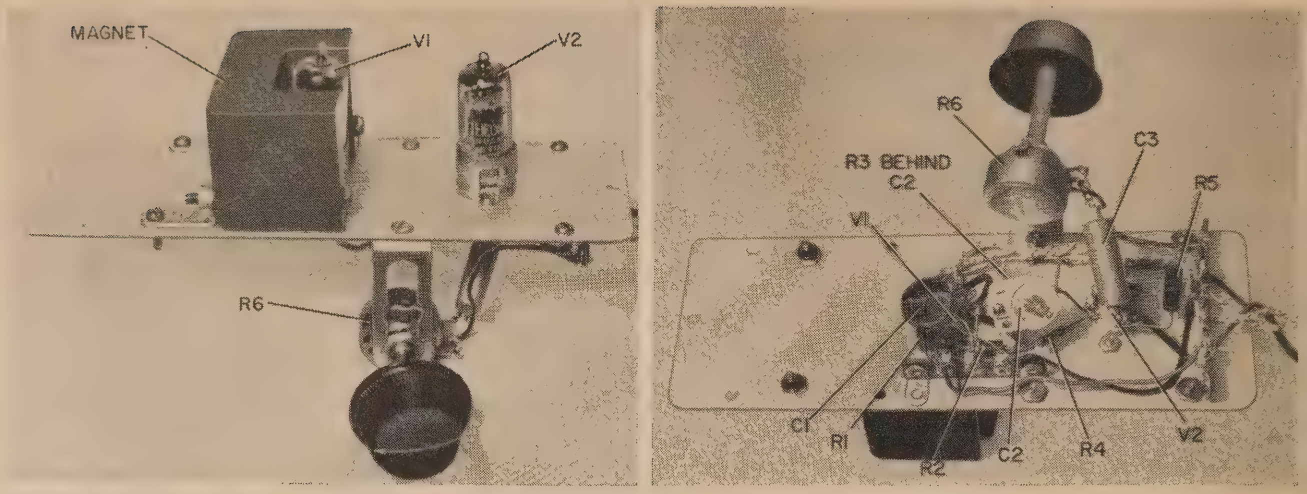


(Left) A view of the finished generator. You can, of course, use an honest-to-goodness chassis instead of the metal breadboard shown here. Underneath (right) view is at right.

random-noise generator

This white-noise source uses a gas tube in a magnetic field

By PAUL S. LEDERER

The use of broadband electrical noise to simulate signals encountered in such systems is common in noise-interference tests on radar, tests on electronic countermeasures equipment, simulation of telephone-line noise, and others.

In addition, the fact that such random electrical noise has a uniform spectrum over a wide frequency range makes it useful for resonance tests, room acoustics tests, measurements of sound attenuation in various materials.

In resonance tests, for example, if you wish to find the series-resonant frequency of an rf choke, a source of white noise feeds the vertical amplifier of a scope through the choke. Since white noise contains all frequencies, but the choke series-resonates at a particular frequency (that is, has minimum impedance at that frequency), most of the energy at that frequency will pass through the choke to deflect the beam. Much less energy over the rest of the band will be fed to the scope. Consequently a fairly decent sine wave at the choke's series-resonant frequency will appear on the scope. In a similar manner, resonant frequencies of speakers may be found.

White noise is used in the aircraft and missile industry to help simulate the severe flight environments. A powerful white-noise generator may be used to drive a bank of speakers to produce high-level acoustic noise for fatigue-testing structures. [For a more detailed account of this application, see "Big Noise" on page 59.—*Editor*]

Audio analgesia

Recently, a fascinating application of white noise has become publicized: "audio analgesia" in dentistry. This is the use of white noise to suppress the pain of dental work. The patient wears a pair of earphones. Music and white noise are fed to the phones. The amplitude of each can be regulated by the patient. While the main function of the music is to relax the patient and relieve his anxiety, the white noise is the real pain killer. It works apparently because of the fact that our nervous system can only take so much stimulation. When the system is overloaded, no further stimuli will be transmitted. The white-noise level is set by the patient until the nerve paths are overloaded enough to block pain impulses.

While more work is needed in this field, such audio analgesia systems are being used quite successfully. These systems employ white-noise recordings. In view of the relative inconvenience of a record and the many other experimental possibilities, I decided to try to build a white-noise generator.

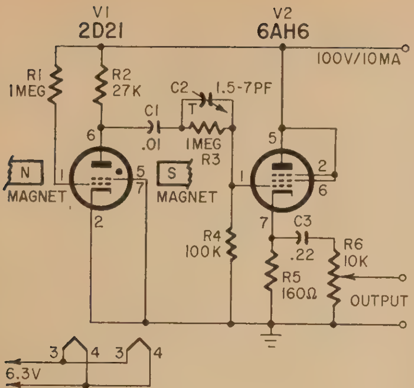
Commercial generators exist. They appear to be based on a design described by J. D. Cobine and J. R. Curry in "Electrical Noise Generators" (*Proceedings of the IRE,* September, 1947). The scheme uses a gas-filled tube as the basic noise source. The gas is ionized by the voltage across the tube and the resulting ions have a random motion, arriving at the cathode in a random time distribution. This ion current causes random voltage drops across the plate load resistor. A thyratron is commonly used as a noise source, though its noise output is not completely random but contains some recurrent components. These can be eliminated by applying a magnetic field along the direction of current flow in the tube, which also raises the level of the high-frequency noise components.

The random-noise generator to be described consists of a 2D21 thyratron noise source feeding a triode-connected 6AH6 cathode follower. A cathode follower provides a low source impedance for feeding low-impendance loads.

A U-shaped permanent magnet 2⅝ x 1⅝ x 1⅝, No. TM 10K25, was obtained from Herbach & Rademan, 204 Arch St., Philadelphia, Pa. The tube is mounted completely within the "U" of the magnet (see photo). Magnet position will affect both randomness and output level and should be adjusted for best results.

A 1-megohm resistor from B-plus to grid of the thyratron assures ionization whenever the power supply is turned on.

The output from the thyratron's plate load resistor is connected to the cathode follower through a capacitor



R1, R3—1 megohm
R2—27,000 ohms
R4—100,000 ohms
R5—160 ohms
R6—pot, 10,000 ohms, linear
All resistors 1 watt, 10% except as noted
C1—.01 µf 400-volt ceramic
C2—1.5-7 pf ceramic trimmer
C3—.22 µf 200-volt paper
V1—2D21
V2—6AH6
Chassis to suit
Sockets, miscellaneous hardware
Magnet—see text

Schematic of noise generator. Though R5 is not especially critical and could be a 10% resistor, 160 ohms is usually available only in 5% tolerance.

not always be necessary since the noise output level varies for each thyratron. This resistor is bypassed by a small trimmer (C2) which is adjusted for optimum output. A 10,000-ohm potentiometer at the cathode-follower output can be used to vary the noise generator output.

For a noise output level of about 1 volt peak to peak, 100 volts at about 10 ma is ample. Increasing the supply voltage does not measurably increase noise level.

Quality of the noise generator was checked on a sweeping type of frequency analyzer and appeared to be within ±3 db from 1 kc to beyond 200 kc. However, it is possible to get a good idea of the quality of the generator by displaying the noise on a scope. A horizontal luminous band of relatively constant amplitude should appear, no matter what the sweep speed. No distinct recurrent frequencies should appear at any sweep speed. (If a 120-cycle signal appears, check power supply filtering or possible heater-cathode leakage.) The luminous band should be brightest in the center, with brightness decreasing equally at equal distances from the center. The top and bottom edges of the band should show jagged peaks of varying amplitudes.

The trimmer, C2, is adjusted till the luminous band is as described. END

References

"Electrical Noise Generators," by J. D. Cobine and J. R. Curry, *Proceedings of the IRE*, September 1947.
"A New Generator of Random Electrical Noise," by A. P. G. Peterson, *The General Radio Experimenter*, January 1960.
"The Noise That Banishes Pain," by C. Fowler, *Popular Electronics*, January 1961.

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equipment report

Color generator
(B & K model 850)
and
Sine/Square-Wave generator
(Lafayette TE-22)

THE MOST IMPORTANT COLOR TESTS ARE those made when a color TV set is installed. Unless convergence and purity are correctly set up at this time, you can have a lot of customer complaints! Correct test equipment is essential.

The B & K model 850 color generator is a single-unit instrument that will make all these tests besides having many useful bench applications for troubleshooting.

Dot, crosshatch, vertical and horizontal lines are provided from a "countdown" (divider) circuit using a 189-kc crystal oscillator. All signals come from the same source, giving the convergence patterns very high stability.

An unusual color test signal is provided by a crystal oscillator on 3.579545 mc. The output of this is fed to a fixed delay line (Fig. 1), and any desired phase angle can be selected with a rotary switch. This allows the use of single colors, or any of the "demodulator axes" used in color TV circuits: I and Q, or X and Z.

A GUN KILLER rotary selector switch is used to kill any gun or combination of guns. This can be very useful during convergence. The same switch also can be used to bring the signal on any of the three grids to a jack on the panel. The scope can be connected at this jack, and the single-color signal used in combination with the GUN KILLER switch, pattern selector, etc. to check the performance of any demodulator. For example, the switch can be set to the green grid, and a blue or red signal fed in: there should, of course, be no signal on the green grid. Any combination like this can be used.

Demodulators may also be aligned without the scope. By setting the GUN KILLER to any single gun, and feeding in signals of *other* colors, the demodulators can be checked and, if necessary, adjusted. For example, if we had the blue gun on, and a green signal caused contamination, we'd know that there was trouble. While this is very rare, unless there has been tinkering, it can happen, and it can be rough to cure! With this method, it should be easy.

This could also be used to advantage on the service bench, with only the chassis of a color TV. By connecting the base adapter to the CRT socket, de-

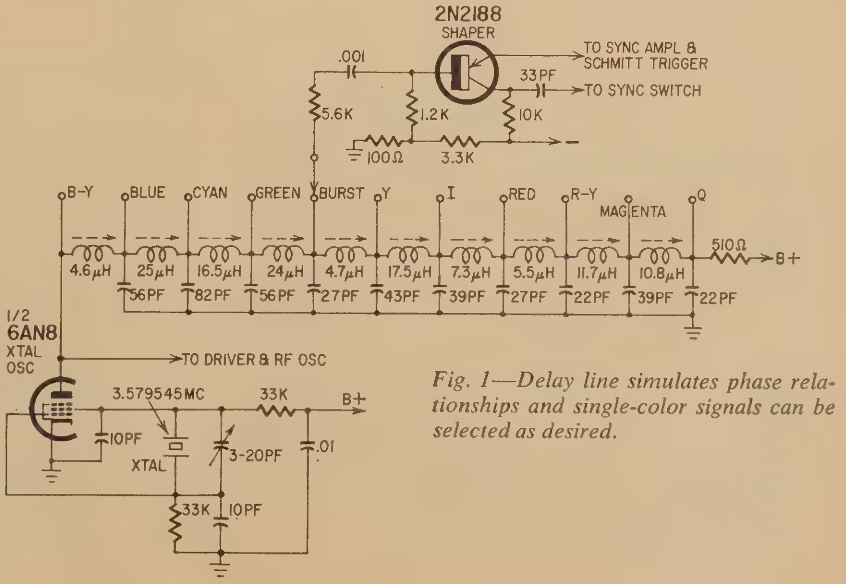


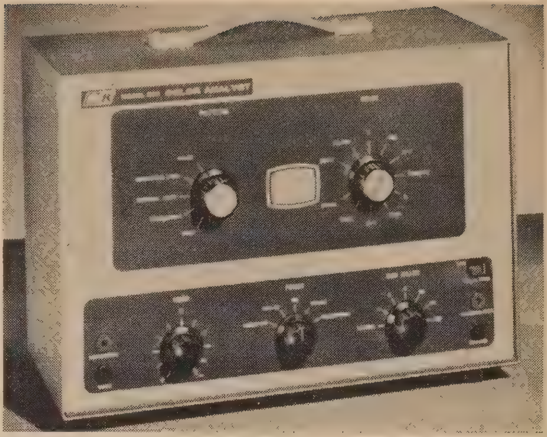
Fig. 1—Delay line simulates phase relationships and single-color signals can be selected as desired.

modulators and other circuits can be aligned using a scope as indicator.

Video signals are provided; these can be fed into any of the color or video circuits, with either positive or negative polarity. A zero-center pot (VIDEO) on the front panel controls this. Any of the dot signals or the color signals can be used as modulation. A horizontal sync signal for the scope is also provided on the front panel.

Rf output comes through a terminated probe with either 300-ohm or 75-ohm output. No rf gain control is used, the output level being set at about the "normal" level for good reception. Channel 3, 4 or 5 can be used; a slide switch on the back of the 850's case selects the desired one.

There's liberal storage space for adapters, test leads, etc., in the back. A novel feature of the instrument is a small electromagnet that can be clipped on the neck of the color picture tube. When energized, it throws the tube out of convergence for checking linearity.—*Jack Darr*



B&K model 850.

Lafayette TE-22 sine/square-wave generator

THIS COMPACT (7 x 10 x 5 INCH) THREE-tube unit gives five-tube performance in generating sine waves from 20 to 200,000 cycles, with a calibration accuracy of ±3%, in four decade bands: 20 to 200, 200 to 2,000, 2,000 to 20,000 and 20,000 to 200,000 cycles.

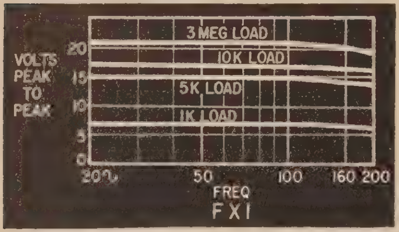


Fig. 2—Plot of lowest decade (20-200 cycles) on Lafayette TE-22 shows constant output. Other decades, to 200 kc, are as good or better. Waveforms remain clean even with low load resistance.

Square waves (20 to 30,000 cycles) are read on the same scales. Specifications claim 5% tilt of the square wave at 60 and 5% rounding at 30,000 cycles.

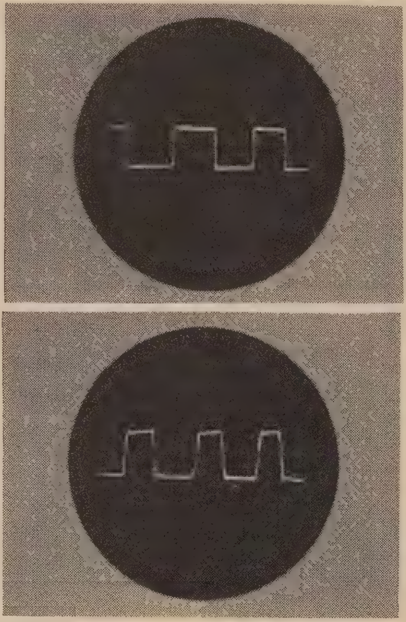


Fig. 3—Scope trace of 10-kc square wave (top) and 100-kc square wave.

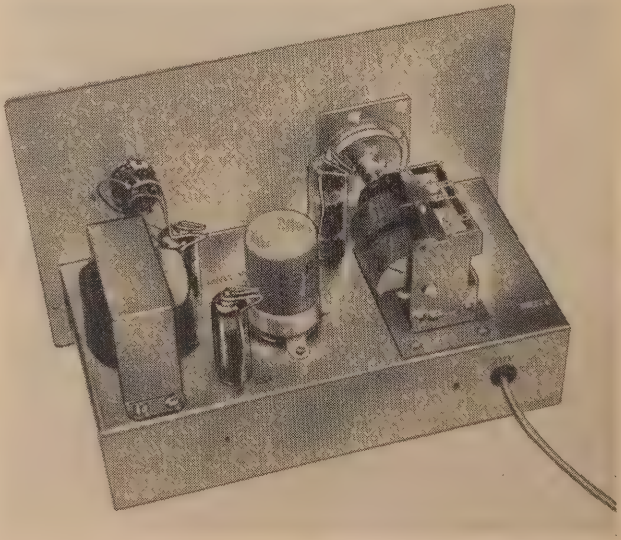
All tests showed the specifications to be accurate and the frequency response quite flat, whether loaded only by the input of a scope or by an external 1,000-ohm resistor (Fig. 2) for square and sine waves.

The flat output of the generator reduces the need to meter amplifier input level for the usual audio signal injection applications of sine and square waves for test purposes.

Above 30 kc the square waves are no longer square (Fig. 3), but the square wave output can be fed into a TV video amplifier to produce a bar pattern. About 125 kc produces eight vertical bars. A square wave of 240 cycles is high enough to make six horizontal bars to check vertical linearity.

The specifications in the instruction manual give the output as 7 volts maximum. This can be misleading—it is 7 volts rms or nearly 20 volts peak to peak—much more than would be expected.—*Elmer Carlson*

LAFAYETTE RADIO
MODEL TE-22
AUDIO GENERATOR
SINE AND SQUARE WAVE
WAVE FORM



Lafayette TE-22.

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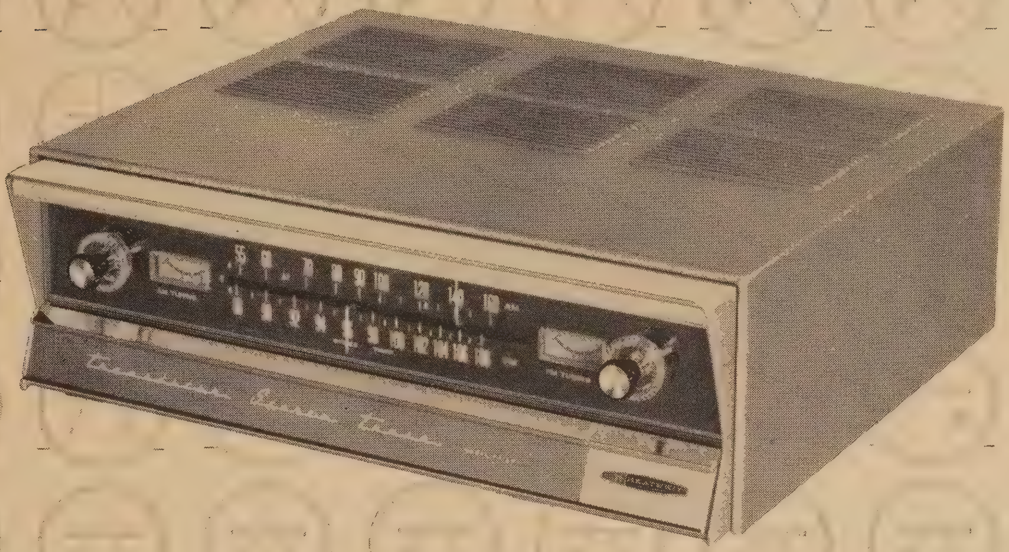

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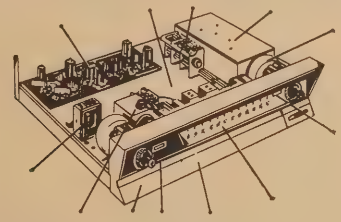

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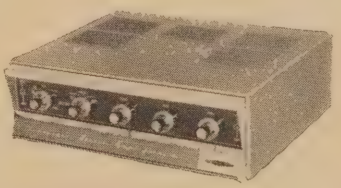

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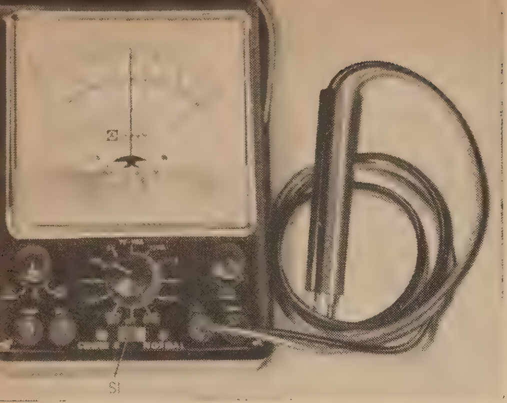


zero-center reading for dc voltmeters

By **JAMES E. PUGH, JR.**

SOME DC VOLTAGE MEASUREMENTS ARE easier to make with the zero position at the center of the meter scale but, unfortunately, very few meters have this convenience. A simple modification can add this feature to nearly any meter, whether vom, vtvm or panel type. In many cases the only extra parts needed will be a switch and a resistor. In some cases a potentiometer and a battery will also be needed.

A Knight 1,000-ohm-per-volt meter was modified to show how easy it is. The same principles will apply to any meter. A dpdt switch (S1) was installed to switch the internal battery and ohms adjustment potentiometer from the ohmmeter circuit directly across the meter (dc only). This makes it possible to bias the meter to set the zero reading to any desired position, although we will normally be interested only in the half-scale point.

When S1 is in the CENTER 0 position R2, normally the ohms adjustment, sets the meter bias, while R1 limits the maximum possible meter current to a safe value in case R2 is accidentally set to its minimum. In some cases it may be a good idea to replace the original R2 with a larger one to take care of a wider range of battery wear. For example, with the vom shown it was increased from 600 to 2,000 ohms to permit a one-half-scale adjustment over a battery output of 1.6 down to 0.8 volt.

The resistance values shown will be close to the optimum for most 1,000-ohm-per volt meters. With meters of other sensitivities they will need to be changed. To do so, set R2 at minimum resistance and make the resistance of R1 such that slightly more than one-half-scale deflection is obtained with the minimum usable battery voltage. Then with R1 in place, make R2 large enough so that, when set at its maximum resistance point, slightly less than a one-half-scale reading is obtained with a new battery.

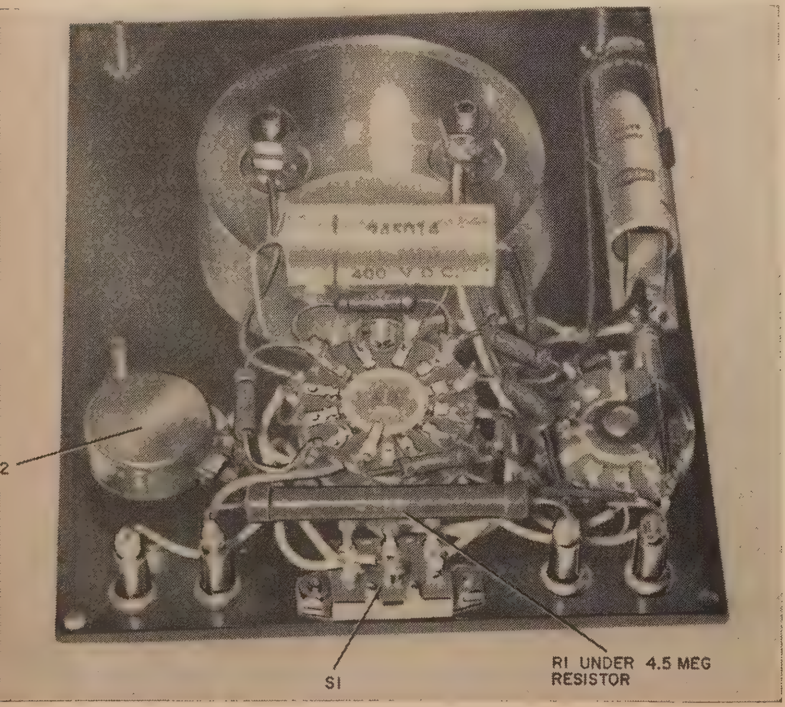
In complex circuits, or if your meter lacks the components, it will be necessary to add a meter and potentiometer instead of "borrowing" these components from the ohmmeter circuit. In this case use a battery that will give a reasonably long service. For most meters the type-AA penlight cell will be satisfactory, although where it is to be used often or where the meter current is higher than a few milliamperers a larger battery will be better.

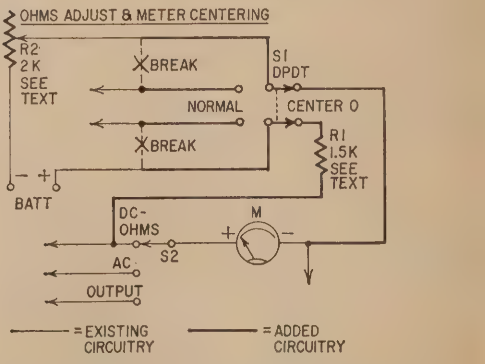
To use it, throw S1 to the CENTER 0 position and adjust R2 for one-half-scale reading with no voltage across the external probes. Now a positive voltage across the probes will make the meter read up, and a negative voltage will cause a downward deflection.

The error introduced by this circuit will be negligible on all but the very lowest voltage ranges, because of the isolation provided by the meter's multiplier resistors. Also, the error on the lowest range will not be noticeable, if the resistance of the circuit being measured is at least several thousand ohms. Some idea of the worst possible error can be had by touching the meter probes together. It will be very small in any case.

For ordinary use, S1 is set to NORMAL where it connects the battery and potentiometer back into the ohmmeter circuit, and leaves R1 unused in the CENTER 0 circuit. With everything thus returned to normal, the meter then functions exactly as it did before it was modified.

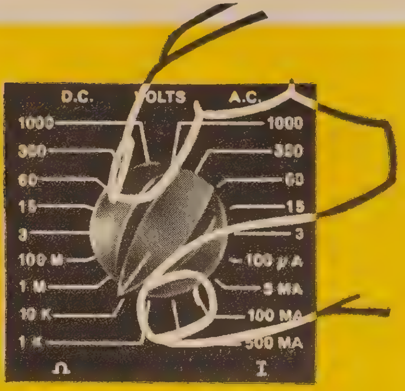
In addition to its usefulness in discriminator, bridge and other balance measurements, this meter when in the CENTER 0 position is fine for making rapid radio and TV checks. It will read both positive and negative voltages without reversing the probes. Much time can be saved making routine tests this way. END





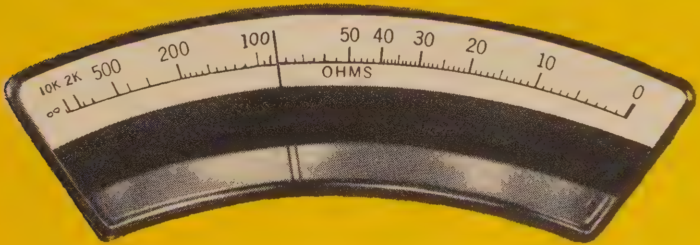
The needed circuit changes, and an inside photo of the meter showing the components involved.

See Only the Scale You Want...in the Exact Range You Want



just set the range switch

and the correct scale appears AUTOMATICALLY



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100-kc Crystal Calibrators

A 100-kc crystal calibrator can be very helpful in locating the exact edges of the ham bands and checking whether your dial calibration is correct. Some receivers, like the Drake, have a movable dial plate which may be shifted to correct errors in calibration. A calibrator will discover such errors.

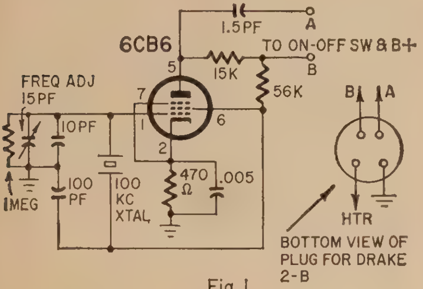

Fig. 1

Fig. 1 is a circuit that provides high harmonic output to at least 30 mc. I built it into an open-channel type chassis measuring 1¾ x 3⅛ x 1 inch. The Drake 2B receiver comes equipped with a Cinch 2675 socket (four-pin) for power and output connections of such a calibrator. The chassis was constructed with a battery type plug for insertion into the calibrator socket. The Drake is also equipped with a panel control for switching plate voltage to the calibrator. Heater power is applied continuously while the receiver operates.

This circuit may be used, of course, with any short-wave receiver not already equipped with a calibrator. The variable control is for adjusting to WWV.

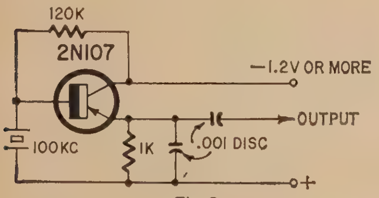

Fig. 2

A much simpler calibrator is shown in Fig. 2. Note how few components are required. It will function with as little as 1.2 volts. Output may be raised by increasing this to 6 volts. With close coupling to the antenna post of a sensitive receiver, harmonics may be heard to approximately 10 mc or higher.—*I. Queen*

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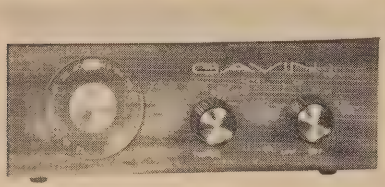
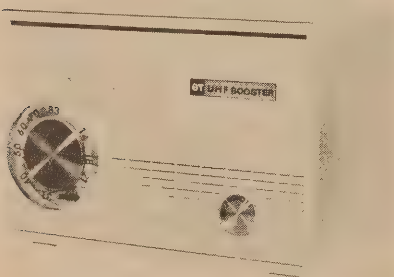
Ultra Vista

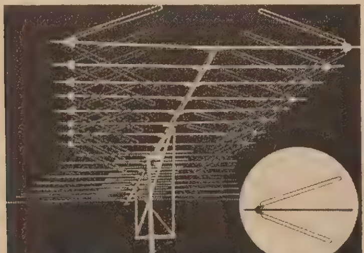
UHF CONVERTER, *model G-4d.* Grounded-cathode double nuvistor circuit, vernier tuning, ac outlet, uhf-vhf coupler.—**Gavin Instruments, Inc.,** Depot Square & Division St., Somerville, N. J.



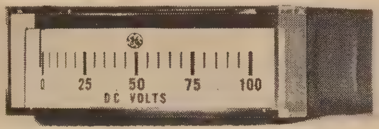
ALL-CHANNEL UHF BOOSTER, *U-Boost,* adds up to 15 miles to reception range of uhf. Gain exceeds 10 db, input and output 300 ohms balanced. Power 117 vac, 60 cycles, 0.1 amps. Neon pilot light.—**Blonder Tongue Labs,** 9 Alling St., Newark 2, N. J.



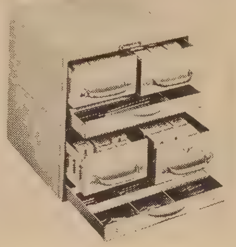
FRINGE-AREA TV/FM ANTENNA, *model 3607-G Super Crossfire.* 3-band director system combines low- and high-band TV plus FM on single element; phase controllers with folded cat's-whisker stubs on each director. Up to 16:1 front-to-back ratios. *Model 3606-G, Telstar Crossfire,* same antenna with built-in transistor booster.—**Channel Master Corp.,** Ellenville, N. Y.



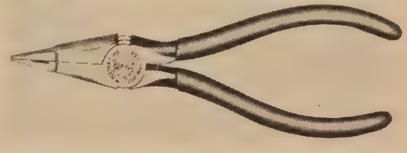
EDGEWISE INDICATORS, *type 185.* Self-shielded ammeters and voltmeters, vertical or horizontal mounting. Ac rectifier models, dc ratings 20 μamps to 10 amps self-contained, 300 volts max. self-contained.—**General Electric,** Schenectady 5, N. Y.



DUAL CONCENTRIC CONTROL KIT, *Fastach II, FRK-200.* 36 controls, 65 exact-replacement front and rear shafts, 8 standard switches, 5 push-pull switches, 45 push-pull and standard universal shafts, 5 twist-tab plates. Plug-in, snap-together assembly. Replacement guides included.—**Centralab,** Electronics Div. Globe-Union, Inc. 900 E. Keefe Ave., Milwaukee 1, Wis.



LONG-NOSE CUTTING PLIER, *model D317-6PC.* Cutting knife ¼-inch back from knurled tip. Coil spring keeps Plastisol-dipped handles open.—**Mathias Klein & Sons, Inc.,** 7200 McCormick Rd., Chicago 45, Ill.



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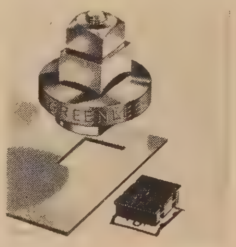
RELAY SOCKET PUNCH, *model 731-R.* Makes quick holes in up to 16-gauge metal. All holes exactly 1.015 x .859-in.—**Greenlee Tool Co.,** Rockford, Ill.

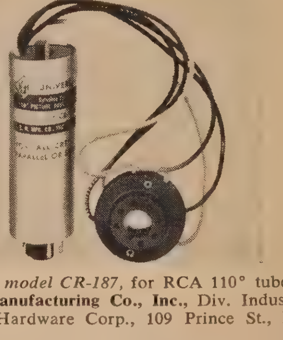


PENCIL SOLDERING IRON, *model W-P.* With tip and cord set. Rated at 25 watts, weight 1¾ oz. Max. tip temperature 860°F. Interchangeable tips, replaceable parts including heating element and cord set.—**Weller Electric Corp.,** 601 Stone's Crossing Rd., Easton, Pa.

TUBE PULLER, *model TP-1,* for removing, inserting nuvistors. Internal spring mechanism grips tube without damage.—**Cinch Mfg. Co.,** 1026 S. Homan Ave., Chicago 24, Ill.

TUBE ADAPTER, Magnoval, (illus). 9-pin socket installed into standard octal plug. Fits all tube testers with standard octal sockets. *Pin straighteners* protect sockets and tubes from bent-pin damage. 2 mounting holes for screw or bolt-down mounting on testers and service benches.—**Seco Electronics, Inc.,** Dept. 164, 1201 S. Clover Dr., Minneapolis 20, Minn.

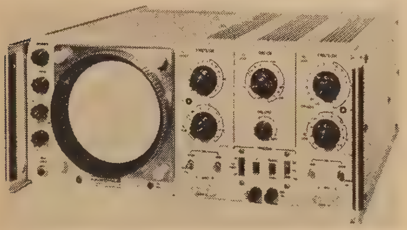
PICTURE-TUBE BOOSTERS. 3 types cover every tube made, all voltages and currents, series or parallel circuits. *Model CR-188* (illus), for Sylvania 110° tubes; *model CR-186,* for all 70°–90° CRT's, *model CR-187,* for RCA 110° tubes.—**I. E. H. Manufacturing Co., Inc.,** Div. Industrial Electronic Hardware Corp., 109 Prince St., New York, N. Y.



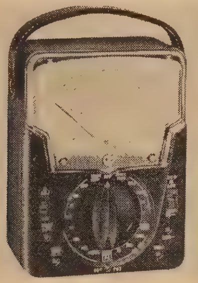
PORTABLE CRT TESTER/REJUVENATOR, *model 36-616.* Cathode-emission test applies high-voltage pulse to second anode of CRT. Selector indicator lights, large calibrated dial. Adaptable to 110° picture tubes. Checks shorts, continuity and leakage with life test. Controlled dc shot reactivation cleans cathode surface for

normal emission provided by 3 levels of reactivation intensity.—**GC Electronics Co.**, Div. Textron Electronics Inc., 400 S. Wyman St., Rockford, Ill.

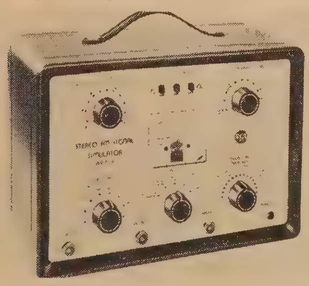
RACK OR SYSTEMS SCOPE, *type 704.* Bench or rack mounting. Identical X and Y amplifiers, bandwidth dc to 500 kc. Critical circuits use silicon semiconductors. Modular internal construction. Tight-tolerance mono-accelerator cathode-ray tube driven directly from transistorized amplifiers. Epoxy-impregnated power transformer. Optional 10 x 10-cm internal nonparallax graticule with edge lighting. Pushbutton beam finder; sweep expander; auto, normal and single sweep triggering; internal calibrator; balanced input on attenuator ranges.—Scientific Instrument Dept., **Du Mont Labs**, Div. Fairchild Camera & Instrument Corp., 750 Bloomfield Ave., Clifton, N. J.



VOLT-OHMMETER, *model 630-L,* for semiconductor testing. 2 special low-power ohms circuits on ×1 and ×10 ranges. Maximum open-circuit test voltage 0.140, maximum power dissipation in semiconductor under test 420 μw. High sensitivity 20,000 ohms per volt dc, 5,000 ohms per volt ac. Dc accuracy 3%, ac 4%.—**Triplett Electrical Instrument Co.**, Bluffton, Ohio.

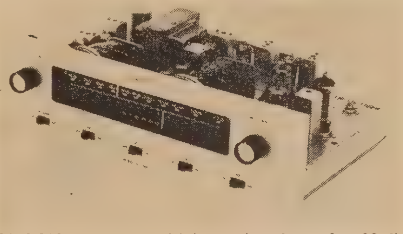


STEREO FM SIGNAL SIMULATOR, *model WR-51A.* Signals for service and maintenance of FM multiplex adapters or stereo FM receivers. 60-db 3-step attenuator for rf output signals; zero-center meter; two cables permanently wired for connection to amplifier voice-coil output terminals.—**RCA Electron Tube Div.**, Harrison, N. J.

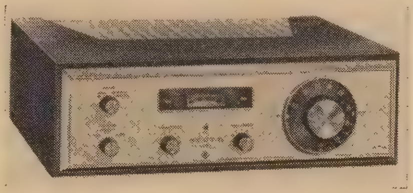


SIGNAL GENERATOR, *Eldeco Port-O-Gen.* Cigarette-pack size, battery-operated for CB or amateur radio. Modulated signal for rf/i.f. alignment, spotting tunable receivers, checking crystal activity, etc. 2 crystal sockets for large and small crystal pins.—**Electronic Devices Corp.**, 4212 Ponce de Leon Blvd. Coral Gables 46, Fla.

FM/AM STEREO MULTIPLEX TUNER, *model 3157MX.* Edge-lighted slide-rule dial, flywheel tuning, Multiplex monitor indicator light. FM frequency response 20-20,000 cycles ±1 db, IHFM sensitivity 3.5 μv. AM frequency response 20–8,000 cycles, sensitivity rating 3 μv for 20-db signal-to-noise ratio. Channel separation 30 db at 1,000 cycles. 67- and 38-kc rejection filters in MX decoding units.—**Eric Electronics Corp.**, 2115, Colorado Ave., Santa Monica, Calif.

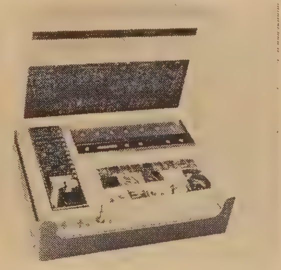


FM STEREO TUNER, *model 310E.* Front-panel recorder output jack; lab-type precision vernier tuning control; mode control with FM mono, FM stereo, FM stereo automatic positions. Interstation noise suppressor; silver-plated rf cascode front end; 2-mc wide-band detector, 3 limiting stages, agc.—**H. H. Scott Inc.**, Dept. P, 111 Powdermill Rd., Maynard, Mass.



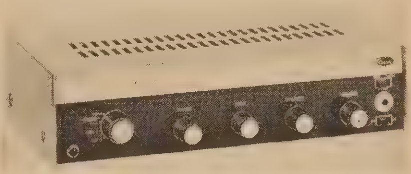
STEREO POWER AMPLIFIER, *Stereo 35.* Wide-band low-distortion output 17½ watts per channel. Full 35 watts available continuously over 20–20,000 cycles. Use with manufacturer's PAS-2 or similar stereo amplifier.—**Dynaco, Inc.**, 3912 Powelton Ave., Philadelphia 4, Pa.

STEREO PREAMPLIFIER KIT, *Citation A,* now in kit form. For specs, see *Radio-Electronics,* July 1963, page 32.—**Harman-Kardon, Inc.**, Ames Ct., Plainview, N. Y.



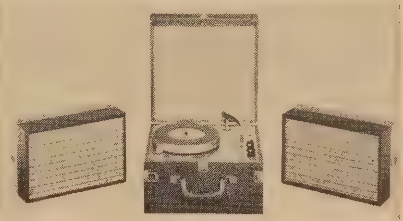
MONO/STEREO TAPE PREAMP, *model KN-4002.* Twin visual indicators, concentric dual playback, record controls for each channel. Equipped for multiple recording, echo-chamber sound, other special effects. Bias frequency preset to 65 kc. Separate equalization for 3¾–7½-ips speeds. Dc-operated tube heaters on input stages. Response at 7½ ips, ±3 db, 30–16,000 cycles. Hum and noise —50 db on playback. Input impedance: mike, 3.3 megohms; aux, 100,000 ohms. Record sensitivity: mike, 2 mv for max level at 1 kc; aux, 200 mv. Output impedance 10,000 ohms.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

15-WATT STEREO AMP, *model AM-217.* Built-in preamps accommodate any magnetic cartridge. Standard 3-circuit jack on front panel for most stereo headphones. Output 7.5 watts per channel; frequency response 20–20,000 cycles. 110–125 vac, 60 cycles.—**Olson Electronics, Inc.**, 260 S. Forge St., Akron 8, Ohio.

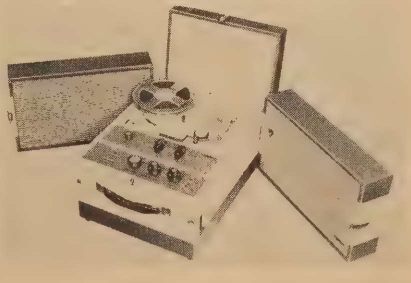


PORTABLE STEREO PHONOGRAPH. Solid-state unit plays mono and stereo records, AM and FM stereo broadcasts. Extra compartment and input jacks for optional matching AM/FM stereo tuner. Transistorized amplifier, output 15 watts music power; 2 dual speakers, Garrard record changer with magnetic cartridge. Speaker enclosures can be separated.—**Pilot Radio Corp.**, 37-06 36 St., Long Island City, N. Y.

STEREO PHONOGRAPH, *model 12-S* Portable classroom phono plays stereo and mono. Polyurethane turntable pad, two 8-inch detachable dual-cone extended-range speakers latch together for carrying. Stereo headphone/speaker output jacks; preamp outputs for stereo tape recording or external amplifier system; stereo balance control.—**Rheem Califone Corp.**, 5922 Bowcroft St., Los Angeles 16, Calif.



PORTABLE STEREO TAPE RECORDER, *Kit AD-72.* Records and plays 4-track stereo and mono tapes. 7½, 3¾ ips. Mike and line inputs;



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☐ **10—SETS PHONO PLUGS & PIN JACKS** RCA type $1
☐ **20—ASST. PILOT LIGHTS** #44, 46, 47, 51, etc. $1
☐ **20—PILOT LIGHT SOCKETS** bayonet type, wired $1
☐ **50—ASSORTED TERMINAL STRIPS** 1, 2, 3, 4 lugs $1
☐ **100'—FINEST NYLON DIAL CORD** best size, .028 gauge $1
☐ **50—ASST. RADIO KNOBS** screw and push-on types $1
☐ **25—ASST. CLOCK RADIO KNOBS** in colors $1
☐ **25—ASSORTED PRINTED CIRCUIT SOCKETS** best types $1
☐ **1—LB SPOOL ROSIN-CORE SOLDER** 40/60 $1
☐ **25—BALL POINT PENS** Retractable, assorted colors $1

☐ **5—SELENIUM RECTIFIERS** standard 300ma type $1
☐ **100—ASSORTED ½ WATT RESISTORS** some in 5% $1
☐ **70 — ASSORTED 1 WATT RESISTORS** some in 5% $1
☐ **35 — ASSORTED 2 WATT RESISTORS** some in 5% $1
☐ **50—ASST. PRECISION RESISTORS** in 1 percenters $1
☐ **20 — ASS'TED WIREWOUND RESISTORS** 5, 10, 20 watt $1
☐ **10 — ASST. RADIO ELECTROLYTIC CONDENSERS** $1
☐ **5—ASST. TV ELECTROLYTIC CONDENSERS** $1
☐ **300—ASST. ½W RESISTORS** AB, IRC, short leads, excellent $1
☐ **10—6' ELECTRIC LINE CORDS** with plug $1
☐ **4—50' SPOOLS HOOK-UP WIRE** 4 different colors $1
☐ **50—STRIPS ASSORTED SPAGHETTI** handy sizes $1
☐ **100 — ASSORTED RUBBER GROMMETS** best sizes $1
☐ **200'—BUSS WIRE** #20 tinned for hookups, special circuits, etc. $1
☐ **250—ASST. SOLDERING LUGS** best types and sizes $1
☐ **1000—ASST. HARDWARE KIT** screws, nuts, washers, rivets, etc. $1
☐ **250—ASST. WOOD SCREWS** finest popular selection $1
☐ **250—ASST. SELF TAPPING SCREWS** #6, #8, etc. $1
☐ **150—ASST. 6/32 SCREWS and 150 6/32 HEX NUTS** $1
☐ **150—ASST. 8/32 SCREWS and 150—8/32 HEX NUTS** $1
☐ **150—6/32 HEX NUTS and 150—8/32 HEX NUTS** $1
☐ **8—ASST. LUCITE CASES** hinged cover, handy for parts $1
☐ **4—TOGGLE SWITCHES** SPST, SPDT, DPST, DPDT $1
☐ **10—ASSORTED SLIDE SWITCHES** SPST, DPDT, etc. $1
☐ **100—ASST RUBBER & FELT FEET FOR CABINETS** best sizes $1
☐ **50—ASST. MICA CONDENSERS** some in 5% $1
☐ **50—ASST. DISC CERAMIC CONDENSERS** popular numbers $1

☐ **WESTERN ELEC. Piece of Equipment** loaded with relays and other valuable parts $1
☐ **6—ASTRON ELECTROLTIC CONDENSERS** 8mfd-450v $1
☐ **6—NICHROME HEATING COILS** 1000 watts $1
☐ **50—ASSORTED TV COILS** I.F. video, sound, ratio, etc. $1
☐ **1—INDOOR TV ANTENNA** Hi-gain, 3 sections, tiltproof $1
☐ **5—TV CHEATER CORDS** with both plugs $1
☐ **3—ELECTROLYTIC CONDENSERS** 50/30-150v $1
☐ **100'—TWIN TV LEAD-IN WIRE** 300 ohm, heavy duty $1
☐ **50' — FLAT 4-CONDUCTOR WIRE** many purposes $1
☐ **20—ASSORTED TV KNOBS ESCUTCHEONS** etc. $20 value $1
☐ **100'—MINIATURE ZIP CORD** 2 conductor, serves 101 uses $1
☐ **1—70° FLYBACK TRANSFORMER** incl. Schematic Diagram $1
☐ **100—ASST. CERAMIC CONDENSERS** some in 5% $1
☐ **1—EMERGENCY AUTO LAMP** Red dome blinker, incl Battery $1
☐ **50—ASSORTED TV PEAKING COILS** all popular types $1
☐ **10—TV PICTURE TUBE SOCKETS** wired with 20" leads $1
☐ **20—ASSORTED GRID CAPS** for 1B3, 1X2, 6BG6, 6BQ6, etc. $1
☐ **10—DIODE CRYSTALS 1N34** $1
☐ **10—ASST. DIODE CRYSTALS** 5—1N60 and 5—1N64 $1
☐ **2—SILICON RECTIFIERS** 750ma, 400 PIV $1
☐ **3—SILICON RECTIFIERS** Top Hat 500ma-400 PIV $1
☐ **50'—INSULATED SHIELDED WIRE** #20 braided metal jacket $1
☐ **32'—TEST PROD WIRE** deluxe quality, red or black $1
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☐ **COMMODORE 5-TUBE RADIO** AC-DC, complete ready to play $5

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☐ **1—SQ. YARD GRILLE CLOTH** most popular brown & gold design $1
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☐ **50—ASSORTED SOCKETS** all type 7 pin, 8 pin, 9 pin $1
☐ **50—ASSORTED TUBULAR CONDENSERS** .001 to .47 up to 600v $1
☐ **6—TRANS. RADIO BATTERIES** 9 volt, same as Eveready #216 $1
☐ **20—ASST ROTARY SWITCHES** all popular types over $20 value $1
☐ **20—ASST. DIODE CRYSTALS** fine assortment. Latest types $1
☐ **2—WIRE STRIPPERS/CUTTERS** adjust to all insulation sizes $1
☐ **3—SPEAKER CABINETS** for 2 1/2" to 3" spkr, all purpose $1
☐ **3—3" RECORDER TAPES** Quality acetate, 150 feet $1
☐ **20—GE #NE-2 TUBES** Neon Glow Lamp for 101 uses $1
☐ **6—TV ALIGNMENT TOOLS** $1
☐ **3—SYLVANIA 35W4 TUBES** $1
☐ **6—I.F. COIL TRANSFORMERS** 456 kc, latest 3/4'' x 3/4'' type $1
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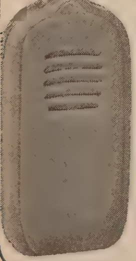
☐ **100—ASSORTED FUSES** 3AG and other popular sizes $1
☐ **20—STANDARD CONDENSERS** .047-600v 85° top quality $1

$200 HEARING AID — For $2



Each HEARING AID is a Complete AUDIO AMPLIFIER and includes CRYSTAL MICROPHONE 3 SUBMINIATURE TUBES Superb Beige CABINET

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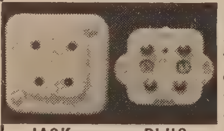

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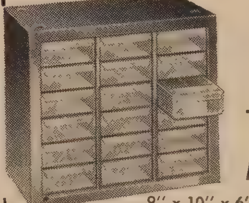
Solves the problem of keeping parts orderly. Joy of using it—See-thru Lucite drawers—and capacity make it worth its weight in gold #18HB 18 Drawers



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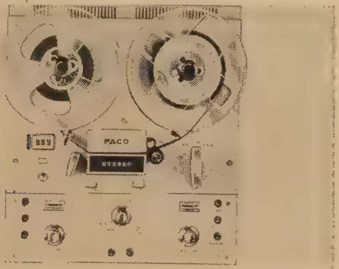
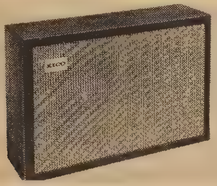
1¼" x 8¾" x 5⅞"
Total Value $7.98
ALL 3 FOR $4.99
9" x 10" x 6" Shpg. Wt. 7 lbs.

BROOKS RADIO & TV CORP., 84 Vesey St., Dept. A, New York 7, N. Y. TELEPHONE COrtland 7-2359 clutched, concentric level and tone controls. Electronic bar type level indicators, dual 2-way speaker systems, free head alignment tape. Wow and flutter at 7½ ips, 0.2%. Power response at 7½ ips, 50–15,000 cycles ±3 db at 2 watts. Harmonic distortion 2% at full output: Up to 7-in. reels.—**Heath Co.**, Benton Harbor, Mich.

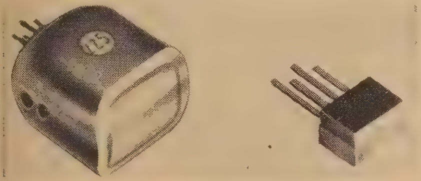
STEREO TAPE DECK/PREAMP. 3-speed Paco unit, rack or custom mounting. Integrated dual preamp. 4-track stereo and mono record/play; 2-track stereo and mono playback. Separate VU meters, digital tape index counter, automatic tape shutoff. Response 30–15,000 cycles ±3 db; ips, flutter and wow 0.4% at 7½ ips. 7-in. reels.—**Precision Apparatus, Inc.**, 8000 Cooper Ave., Glendale 27, N. Y.



2-WAY SPEAKER SYSTEM, *model HFS-10.* 6½-in. low-resonance, high-gap energy woofer-midrange transducer, matched 2-in. tweeter. 5 watts music power per channel. Crossover point approx. 4,000 cycles; response ±6 db, 60–15,000 cycles. Rated impedance 8 ohms.—**Eico Electronic Instrument Co., Inc.**, 33-00 Northern Blvd., Long Island City 1, N. Y.



MAGNETIC REPRODUCING HEADS, *Hall*Istor,* use Hall-effect principle. Play back recorded amplitude in response to flux alone, without regard to tape speed. Not an audio head. *Model SBV-536* (right) Effective gap .0006-in; longitudinal direction of magnetization. For recording tape uses. *Model SBV-535* (left) Effective gap .016-in.; transverse direction of magnetization. For specialized control use. At 25°C ambient temperature: control current—50 ma rated, 75 ma max.; internal resistance 50 ohms control side, 25 ohms Hall side; 200 mv/amp resistive zero component; —2%/°C Hall constant temperature coefficient; soft-iron pole pieces.—**Instrument Systems Corp.**, 111 Cantiague Rd., Westbury, N. Y.



TOOL-LESS SPEAKER KITS. *Coronet I*: enclosure kit and 8-inch MC8 Michigan speaker. *Coronet II*, enclosure materials and Wolverine LS8 speaker. *Coronet III*, enclosure materials and extended-range, 8-inch SP8B speaker. All have interlocking tongue-and-groove joints; 4 threaded rods vertically through unit. Joints lined with adhe-

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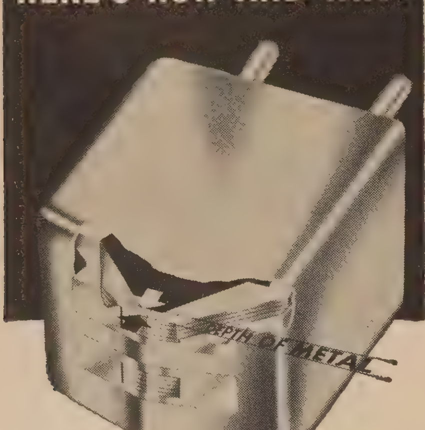
ALL TAPE HEADS WEAR OUT!

HERE'S HOW AND WHY!



Magnetic tape itself is the real cause of head wear!

The abrasive action of tape as it passes over the head face gradually wears away the *depth of metal* left on a new head after final polishing (see above). Because wear is nearly always uneven, craters or ripples are also formed on the face as wear progresses, thus making it impossible to achieve good contact between the head gap and the all-important signal recorded on the tape. The severe high frequency losses and erratic output resulting from poor tape-to-gap contact are very annoying to the ear. Head wear should NOT be permitted to reach this point—much less go beyond it to the limit where the gap actually begins to open up.

By replacing the worn head with a new Nortronics professional type of laminated tape head you will obtain improved high frequency response over the original head, plus the added feature of longer life since laminated heads have 50% more depth of metal at the gap. Nortronics manufactures both laminated and solid-core heads, but recommends the use of the laminated types for up-grading of your recorder.

HAVE YOU CHECKED YOUR HEADS LATELY?
Get the most from your investment in tape equipment. Be certain that head wear is not causing you to lose the clean, crisp sound which only tape gives you. Have your Hi-Fi dealer, Radio/TV serviceman or camera store check your heads for wear. Insist on Nortronics replacement heads and "Quik-Kit" mounting hardware; both correctly matched to your recorder.

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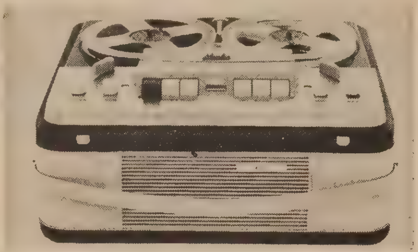
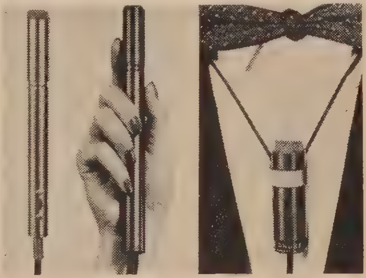
sive-backed gasket tape strips.—**Electro-Voice, Inc.,** Buchanan, Mich.

TRANSISTOR TAPE RECORDER, *Continental 301, model EL3549.* 4 tracks, 4 speeds. 2 preamps for stereo playback through radio, TV or hi-fi system. Speaker, dynamic full-frequency cardioid-pattern mike. Inputs for recording from mike, tuner and phono; facilities for mixing. Input jack for foot control. All 4 tracks can play back simultaneously, prerecorded stereo tapes can play back monaurally. Specs for 7½ ips: response 60–16,000 cycles, signal-to-noise ratio —40 db, wow and flutter 0.14%, mike sensitivity 1 mv. 7-inch maximum reel.—**North American Philips Co., Inc.** 230 Duffy Ave., Hicksville, N. Y.

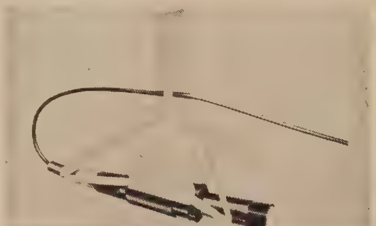


LANGUAGE-LAB MIKE/HEADPHONE, *model T/C 266.* 25,000-, 500- or 10-ohm impedance, frequency response 50–1,000 cycles. Clevite headphones have detachable doughnut ear cushions. Adjustable dynamic mike.—**Turner Microphone Co.,** 909 17th St. N.E., Cedar Rapids, Iowa.

ULTRA-SLIM PROBE MIKES. *Model 578 Omnidyne* (left), for PA. 200 ohms or high-impedance. *Model 576* (center), omnidirectional probe. Dual impedance—50 and 200 ohms—changeable by moving pinjacks inside case. Response 40–20,000 cycles; output—60 db. *Model 570* (right), dynamic lavalier mike.—**Shure Bros., Inc.,** 222 Hartrey Ave., Evanston, Ill.



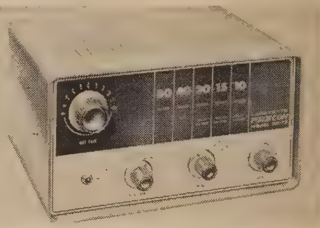
MOVING-COIL MIKES. Selectable output impedance 30/50, 150/250, 20,000 ohms. Mylar polyester Golden Diaphragm has tangential compliance. *Model 688* (illus), omnidirectional. Pickup pattern 360°, response 35–20,000 cycles. *Model 689,* cardiod. Frontal pickup pattern, response 40–16,000 cycles. Both with 15 feet of 2-conductor shielded cable, slip-on swivel adapter.—**Altec Lansing Corp.** 1515 S. Manchester Ave., Anaheim, Calif.



TRIPLE-LENGTH RECORDING TAPE, *No. 290-36.* 3,600-foot lengths on 7-inch reels. 90 minutes uninterrupted recording of single track mono, 2-track stereo, or 3 hours 2-track mono, 4-track stereo, at 7½ ips. Oxide processing provides extra playing time.—**Minnesota Mining & Mfg Co.,** 2501 Hudson Rd., St. Paul 19, Minn.

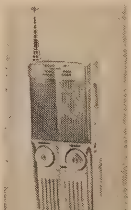
Scotch
Scotch

PRESELECTOR/CONVERTER, *model HE-73 Precon Amateur.* Crystal-controlled, covers 80-, 40-, 20-, 15- and 10-meter amateur bands. Operates on 80 and 40 meters as preselector only; on 20, 15 and 10 meters as preselector or converter. Tuned interstage circuits, 2 stages rf amplification. Gain: preselector, 36 db at 80 meters; converter, 22 db at 20 meters. Output frequency 3.50–5.20 mc. Three crystals for 20-, 15- and 10-meter bands. No power connections to receiver. 117 vac, 50/6 cycles.—**Lafayette Radio Electronics Corp.,** 11 Jericho Turnpike, Syosset, N.Y.

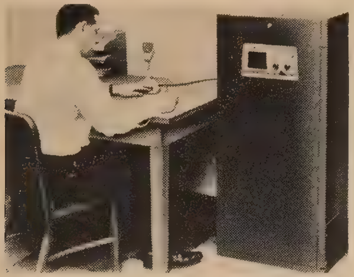


SOLID-STATE AMPLIFIER, *model DV25* Rated power 25 watts at 12.6 volts, operates fro 6 to 12 vdc. Response 100–15,000 cycles ±3 db Gain: mike 115 db; aux, 80 db. Noise: mike 6 db; aux, 80 db. Inputs: 1 mike (high or low im pedance), 1 aux (high impedance, high level) Outputs 4, 8 and 16 ohms. *Model ADV25P* (*il lus*): built-in-solid state ac-to-dc converter fo 117-vac operation.—**Royce Electronic Develop ments, Inc.,** Dept. R, PO Box 321, Valley Stream N. Y.

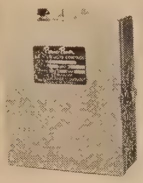
1-WATT WALKIE-TALKIE, *model HE-7* Crystal-controlled 2-way CB radio. 13 transistor 3 diodes, 1 thermistor. 2-stage transmitter, silico output transistors. Superhet receiver has pus pull audio section. Automatic noise limiter, var able squelch. Interchangeable battery compar ment for penlight cells or rechargeable nickel ca mium battery. Plated telescoping whip antenn earphones, 8 penlight cells.—**Lafayette Radio Ele tronics Corp.,** 111 Jericho Turnpike, Syosset, N.



2-WAY UHF RADIO. *Motrac FM Radi phone.* Transistorized mobile unit for 450–470 m 20- and 35-watt models. Less than ½-amp batter drain on standby. *Compa-Station* (illus), 65– and 100-watt indoor base station, plus weatherproof outdoor units. Sensitivity 0.5 μv.—**Motorola Inc.,** Communications Div., 4501 W. Augusta Blvd., Chicago 51, Ill.



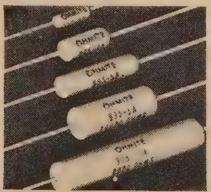
RADIO CONTROL SYSTEM, *model RT-400,* for automatic remote operation of doors, lights, signals, motors, etc. Operating distance outdoors in unobstructed areas, 500 ft. Operates during signal transmission only, or on–off control. Portable pocket-sized transmitter with self-contained antenna and battery, receiver in metal enclosure with flanges for wall mounting. Permanent connection to 115 vac power source by armored cable or conduit; or fitted with flexible attachment. Momentary load-switching relay, actuated during signal reception, plus sequence type.—**Perma-Power Co.,** 5740 N. Tripp Ave., Chicago 46, Ill.



HERMETICALLY SEALED THERMISTORS. In shock-resistant glass, 0.150 inch long, .070-inch diam. Leads 1.125 inches long, .020-inch diameter, gold-plated Dumet, can be welded or soldered. For use to 400°C in temperature compensation, measurement, control and time-delay applications. Available with temperature coefficients —3.3% to —5.1% per °C, in resistances 2,000 ohms–1 megohm.—**General Electric Co.,** Specialty Resistors, Magnetic Materials Section, Edmore, Mich.

FLYBACK TRANSFORMERS. *HVO-214,* exact replacement for Magnavox 360552-1, -2, -2A, 360577-1, 360593-1. HVO-218 for Silvertone 80-14-3, D80-14-3C, D80-14-3E. *HVO-220,* coil-core assembly for Philco 32-8855-1, 32-8855-5.—**Merit Coil & Transformer Corp.,** Merit Plaza, Hollywood, Fla.

MOLDED VITREOUS-ENAMELED RESISTORS. New molded insulation for manufacturer's *Series 99* axial-lead, wirewound resistor. Consistent insulation thickness guarantees 1,000-vac insulation breakdown ratings. Markings vitreous and fired on. 5 sizes, 1–10 watts.—**Ohmite Mfg. Co.,** 3657 Howard St., Skokie, Ill. END



All specifications are from manufacturers' data

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The Blonder-Tongue FMB STEREOBOOSTER is special because it increases signal strength 8 times (18 db gain), while keeping noise down to the bare minimum (noise figure 3.8 db) . . . because it eliminates distortion caused by phase and amplitude variation and by impedance mismatch (low VSWR) . . . because it doesn't overload when there are strong local stations present . . . *and* because it does all these things steadily and reliably. But since Blonder-Tongue *is* the company with the *most* experience in TV and FM signal amplification, how could you expect any less? A must for multiplex stereo, and for mono in weak signal areas . . . installed quickly & easily anywhere indoors. Improves reception with an FM antenna, your TV antenna, or a homemade twinlead dipole. List $21

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TECHNOTES

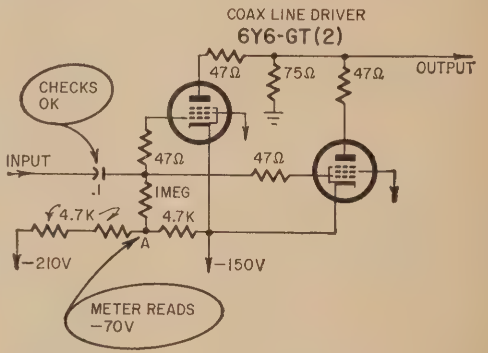
Motorola 84MF Auto Radios

Some of these blow fuses continually when in the car, yet play perfectly on the bench. What happens is that in the car, the set heats up and one of the transistor bias-control terminals expands and shorts out against the base of the control. On the bench, the set's cover is usually off, and heat is carried away.

All you have to do is bend the terminal so that it cannot touch where it shouldn't.—*A. von Zook*

Airfield Radar Video-Line Driver

This circuit (made by Gilfillian and used at most military and civilian airfields) operates normally for several months and then one day, after 15-25 minutes of operation, the 6Y6 tubes begin to draw excessive plate current. The −150-volt supply is consequently overloaded and operation ceases. Tubes test OK, replacement may or may not cure the trouble. What is the difficulty here?



Normal gas liberation from the tubes is causing a grid emission current to develop. This 10-18 μa causes a drop of from 10-18 volts across the 1-megohm grid resistor in opposition to the fixed bias. This small amount of gas will not show on the tube checker. Any fixed bias circuit using a 6Y6, 6L6, 6V6, etc. should not have more than 100,000 ohms in the grid circuit. Replacing the grid resistor with a 100,000-ohm unit will reduce the grid emission drop by 90% and restore circuit stability.—*Lee R. Bishop*

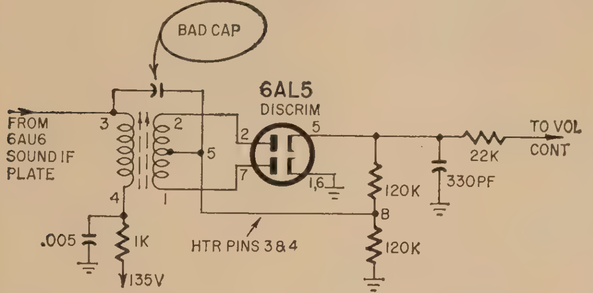
Ekotape Model 111 No Tone Control

Switch section S-1b is not making contact with the tone control contact on playback. Bend the switch contacts so that contact is made on playback position. The tone control is supposed to work only on playback.—*Robert A. James*

Olympic Models 17C44, 17K41, etc.

Complaints of weak picture, loss of sync, and poor sound—all intermittent—were traced to the small capacitor mounted inside the discriminator transformer. It was leaking or shorting intermittently. Sometimes the 6AL5 would get hot, with one plate glowing red. The clue is a heavy positive potential at point B.

The leaky capacitor passes dc through plate pin 7 and cathode pin 1 of the 6AL5 discriminator. Since the same 135-volt line from the cathode of the 6W6 audio output feeds the sync, i.f., (mixer-oscillator) and sound i.f. it throws all these circuits off as well—sometimes turning into a real puzzler.


BAD CAP
6AL5
DISCRIM
FROM
6AU6
SOUND IF
PLATE
3
2
5
2
5
7
1,6
1
4
TO VOL
CONT
22K
330PF
120K
B
120K
.005
1K
HTR PINS 3&4
135V

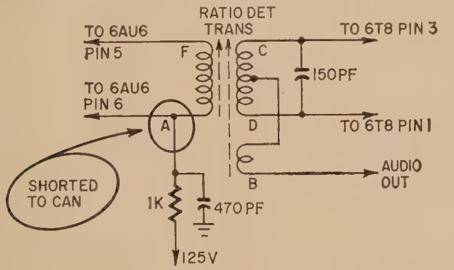
The cure: Replace the discriminator transformer or the capacitor and check the 6AL5 and the 1,000-ohm resistor feeding B-plus to the 6AU6 sound i.f. for possible damage from excessive current.—*George P. Oberto*

Steelman, Airline Recorders: Poor Tone

These recorders are sensitive to head peaking. A slight misadjustment seriously affects output and tone quality. Run a 3,000-cycle tape through the head. Connect an output meter across the speaker leads. Use the external speaker jack. Adjust the screw to the left of the bracket holding the heads, and try for a peak voltage of 4.—*Max Alth*

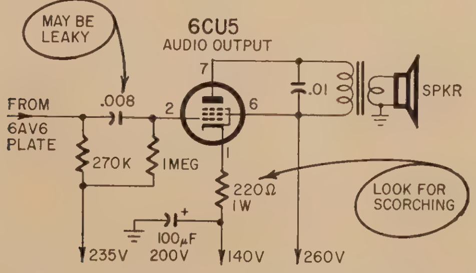
RCA 21D7425U: Intermittent

Complaint: Intermittent picture and sound; raster OK. Cure: Unsolder ratio-detector can from PC board, bend flanges back and pull out. Check for loose or too-long wires touching side of can. Line sides of can with cambric insulation. Reset coil and re-install. Vibrations caused wires to short against inside of can.—*Stan Beger*


RATIO DET
TRANS
TO 6AU6
PIN 5
F
C
TO 6T8 PIN 3
150PF
TO 6AU6
PIN 6
A
D
TO 6T8 PIN 1
AUDIO
OUT
B
SHORTED
TO CAN
1K
470 PF
125V

Philco 7L40—7L70

Always check the 220-ohm 1-watt resistor connected to pin 1 (cathode) of the 6CU5 audio output tube. If it looks scorched, replace it with a 2-watt resistor but, before you go on, check the .008-μf audio grid coupling capacitor for leakage. Leakage here upsets the 6CU5's bias, causing the tube to draw excessive current through the 220-ohm resistor. Replace the capacitor if you're in any doubt.


MAY BE
LEAKY
6CU5
AUDIO OUTPUT
7
.01
SPKR
FROM
6AV6
PLATE
.008
2
6
1
270K
1MEG
220Ω
1W
LOOK FOR
SCORCHING
+
100μF
235V
200V
140V
260V

Since this is a stacked-B set, serious current troubles in the 6CU5 may upset performance in other parts of the set.—*A. von Zook*

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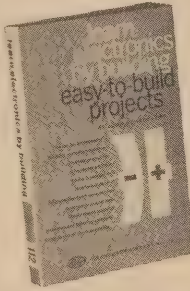

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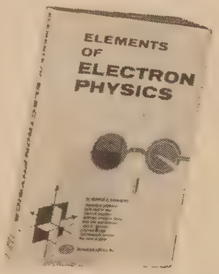

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INDUSTRIAL, MILITARY, SPECIAL-PURPOSE RECEIVING TUBES in 16-page condensed data brochure. More than 600 tubes cross-indexed by type number, function, operating characteristics.—Richard Finger, Industrial Components Div., **Raytheon Co.,** 55 Chapel St., Newton 58, Mass.

PORTABLE BURGLAR ALARM described in 4-page brochure. Photos, drawings, application details on alarm and bedside monitor.—**Pinkerton Electro-Security Corp.,** 275 Main St., Webster, Mass.

POWER VARACTOR DIODES offered in 4-page leaflet, listed by manufacturer's type number. Electrical characteristics, case type, applications, outline drawings, characteristic curves given.—Dr. R. R. Meijer, **Bendix Semiconductor Div.,** South St., Holmdel, N. J.

DC REGULATED POWER SUPPLIES shown in illustrated, 44-page *Catalog B-631.* Specs on 230 standard models, including programmable voltage/current regulated models. Application notes, glossary of power supply terms.—**Kepco, Inc.,** 131-36 Sanford Ave., Flushing 52, N. Y.

ELECTRONIC WIRE CATALOG. 28-page, illustrated *Catalog 862* lists about 75 types wire and cable. Charts show number of conductors, gauges of conductors, shield construction, color-coding.—**Belden Mfg Co.,** 415 S. Kilpatrick, Chicago 44, Ill.

63 REPLACEMENT NEEDLE WALL CHART. Lists needles by manufacturer's cartridge number, shows illustration of needle replacement, record speed, needle number in diamond, synthetic sapphire or osmium.—**Duotone Co.,** Locust St., Keyport, N. J.

CATHODE-FOLLOWER DATA SHEET. Describes model 505 and associated power supply. Designed for precision condenser microphones. Applications in acoustical and accelerometer fields, internal calibration circuitry and construction features, electrical specs, available accessories.—**Dyna Magnetic Devices, Inc.,** Sales Engineering Dept., 110 Duffy Ave., Hicksville, N. Y.

PORTABLE STANDARDS, *Circular 06-108-A.* 12-page brochure details light-beam portable wattmeter, ammeter, voltmeter standards. Photos, complete specs, cross-section views.—**Weston Instruments & Electronics Div.,** 614 Frelinghuysen Ave., Newark 14, N. J.

INDUSTRIAL TUBE GUIDE, *Form T-23.* Data on usage, construction, applications, number and military qualifications of industrial tubes, including ballast, computer, electrometer, hydrogen thyratron, phototube, power triodes, transmitting, voltage amplifier pentodes, voltage regulators.—**Tung-Sol Electric Inc.,** 1 Summer Ave., Newark 4, N. J.

LOUDSPEAKERS/TURNTABLES presented in 10-page illustrated catalog. Includes all manufacturer's models, plus books and accessories.—**Acoustic Research, Inc.,** 24 Thorndike St., Cambridge 41, Mass.

PRACTICAL METHODS FOR CALIBRATION OF POTENTIOMETERS, *Technical Note 172.* 44-page booklet details best means of calibration, discusses circuitry and required circuit measurements. Emphasizes use of universal ratio set.—Superintendent of Documents, **U. S. Government Printing Office,** Washington 25, D.C. **30¢.**

SEMICONDUCTOR DIRECTORY. 40-page *Catalog Supplement 74* lists 5,000 transistor and diode types for industry and military, from 17 manufacturers. Includes new laser equipment.—**Newark Electronics Corp.,** 223 W. Madison St., Chicago 6, Ill.

TAPE RECORDING BOOKLET, *How To Do It.* 20-page 4 x 8-in. pamphlet describes backings, oxide coatings, care of tapes, threading recorder, splicing, editing, use of leader and timing tape. Chart to determine recording times.—**3M Co.,** Magnetic Products Div., St. Paul 6, Minn.

SAMPLING NOTES MONOGRAPH. 12-page illustrated report on sampling scope concepts and systems. Details basic philosophy, pulse definitions and coax-cable characteristics, typical sampling systems, risetime factors, loop gain, sampling density, dot transient response, random-noise smoothing, changing sensitivity, adding dc offset voltage to signal, and timing systems. Over 20 circuit and block diagrams, response curves. Coax-cable length/time chart for 52 and 125-ohm lines. Request on company letterhead.—**Tektronix, Inc.,** Box 500, Beaverton, Ore.

GLASS LIGHTING PANELS. 22-page booklet tells how rf interference can be drained from fluorescent lighting fixtures. Describes manufacturer's electrically conducting No. 70 glass lighting panel, with grounding methods, lighting performance, physical data and photometric data sheets on 5 fixtures.—Building Products Dept., **Corning Glass Works,** Corning, N.Y.

SUBMINIATURE THIN PLATE CAPACITORS. 2-page *Bulletin NPJ-122* describes types TPNPO, TP25, TP89. Lists typical properties, physical dimensions, capacitance ranges, color coding.—Distributor Div., **Aerovox Corp.,** New Bedford, Mass.

LOW-POWER SILICON DIODES. 6-page foldup *Catalog 804* lists 775 types. Comparison chart shows differences between germanium and silicon diodes.—**Ohmite Mfg. Co.,** 3655 Howard St., Skokie, Ill.

FIREPROOF POWER WIREWOUND RESISTORS described in 4-page *Bulletin P-7b.* Details fireproof inorganic construction, application, dimensions, complete specs. Charts and graphs.—**International Resistance Co.,** 401 N. Broad St., Philadelphia 8, Pa.

LOWER THE COST OF FUN WITH TAPE RECORDING. 4 x 6½-in. booklet offers variety of tape tricks, tells how to record from various sound sources. Gives tape quality tests, table of recording times.—**Sarkes Tarzian, Inc.,** E. Hillside Dr., Bloomington, Ind.

SILICON PLANAR/EPITAXIAL TRANSISTORS. 6-page catalog gives full listing and basic specs of high-voltage universal amplifiers, low-level and small-signal amplifiers, universal and uhf and vhf amplifiers and switches, low-storage saturating switches, nonsaturating switches, industrial types and low-level choppers.—**Amperex Electronic Corp.,** Advertising Dept., 230 Duffy Ave., Hicksville, N. Y.

SERVICE TOOLS described in 31-page, looseleaf *Catalog 67.* Includes pliers, adjustable wrenches, cold chisels, wood chisels, punches, nail and rivet sets, screwdrivers, etc. Many displays and assortments. **Rapid-Wrapit Tools,** 4-page illustrated brochure, offers tools for solderless, wrapped-wire connections.—**Utica Tools Div.,** Kelsey-Hayes Co., Utica 4, N. Y.

5 TV PICTURE TUBE DESIGNS. 4-page booklet with photos and descriptions of picture tube types. *Technical Report on Tunnel Diode Measurements,* 8-page leaflet, presents practical methods of measuring series resistance, negative resistance, junction capacitance, maximum frequency of oscillation, resistive cutoff frequency. Illustrated with circuits and graphs, lists manufacturer's microwave tunnel-diode line.—**Sylvania Electric Products Inc.,** 1100 Main St., Buffalo 9, N. Y.

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

technicians' News

Butte Group Joins NATESA

Butte, Mont.—The Electronic Service Association of Butte voted unanimously to affiliate itself with NATESA (National Alliance of Television & Electronic Service Associations). Discussion had been going for some months about this important step.

Raymond G. Tuszynski, the group's corresponding secretary, was elected to the position of NATESA director-reporter for ESA–Butte. Howard Neier was chosen as alternate.

The ESA is currently listed in its own right under "Television—Repairing" in the Butte area "Yellow Pages". Inside the box that encloses member shops' listings in this affirmation: "Members are qualified specialists, meeting the highest ethical & professional standards. Competent to service your radio and television receivers." The group's emblem also appears in the box. The overall impression seems well calculated to bring favorable response.

News From Indiana

Indianapolis—New officers for the coming year's work of the Indiana Electronic Service Association are Jay R. Schupbach, chairman; LaMar G. Zimmerman, Jr., vice chairman, North; Ed Reich, vice chairman, Central; Tom Hendricks, vice chairman, South; John E Hill, secretary; Dean R. Mock, treasurer; David F. Martin, special director.

Fort Wayne—Heading the Fort Wayne Electronic Service Association for '63–'64 are Clyde L. Smeltzer, president; Bob Maxwell, vice president; Kenneth Truman, recording secretary; Eugene Beatty, treasurer; Lindsey Taylor, corresponding secretary, and Tom Hardy, sergeant-at-arms.

The FWESA hopes to start work together with the local Better Business Bureau on a program to combat bait advertising and shoddy workmanship.

Kokomo—The Radio & Television Service Engineers Association of Kokomo met and resolved to examine possibilities of instituting a local licensing ordinance.

The group is interested in embarking on some sort of educational program to build more support for itself, and announces that any help will be appreciated. [By this we assume they might like to hear from other similar organizations in the country that have developed effective "public relations" and promotional campaigns—*Editor*]

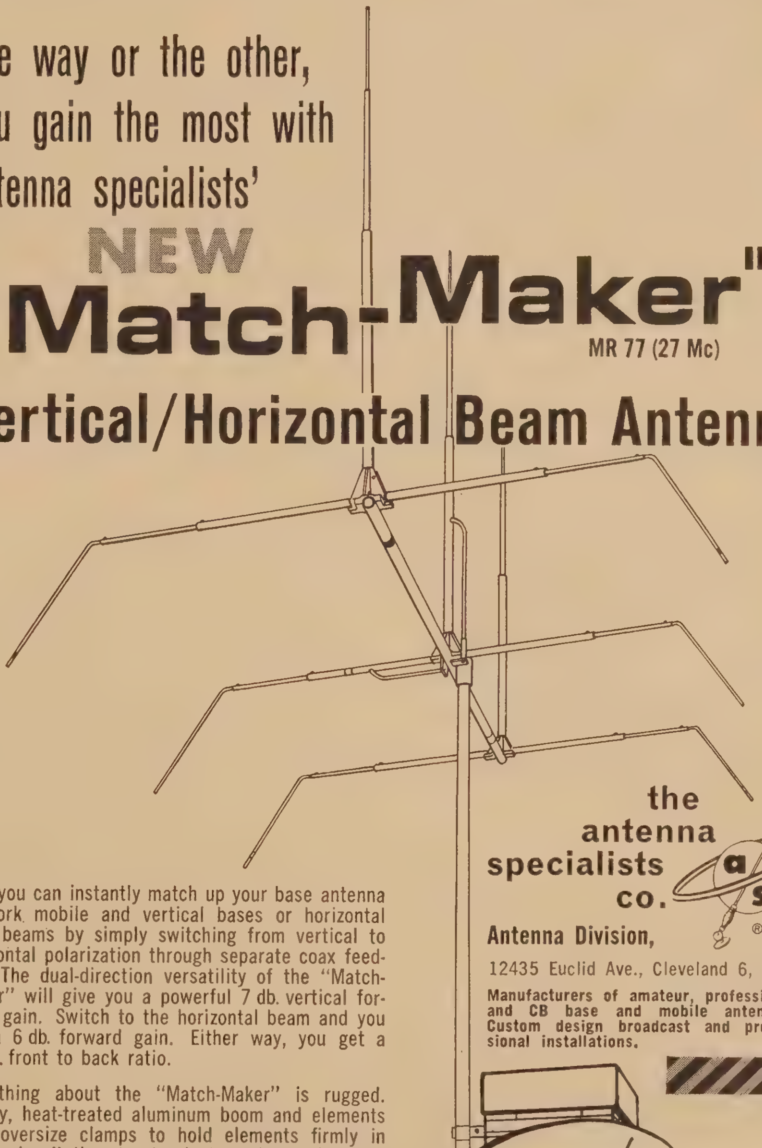
Logansport—The Logansport chapter of the Radio & Television Service Engineers Association met to update its "Credit List"—a service they feel has saved many members from possible loss when customers wanted to charge a call.

IESA Meets

Indianapolis—The Indiana Electronic Service Association met late in April to effect some substantial changes in its makeup and constitution. The size of the board of directors was increased by constitutional amendment, as was the number of officers, "to meet the needs of a growing association."

There are now three vice chairmen, one for each state region (North, South and Central). They can conduct regional meetings, supervise membership expansion and otherwise deal with any problems that arise. They are responsible to the IESA chairman for the association's progress in their areas. A special director was also created, to serve the increasing ranks of individual IESA members not affiliated with local associations.

The group voted to continue liaison



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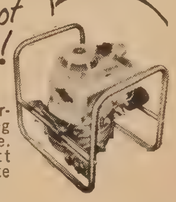

work with NEA (National Electronics Association), the new national organization of state groups. Since NEA's organization is not yet complete, IESA agreed that no motion for actual affiliation with NEA be presented.

Harold C. Joergens, retiring License Committee chairman, and Allan Klineman, lobbyist, presented a final report on their licensing efforts, which failed to get out of state legislative committee. He felt it important to try again for 1965, and Indiana technicians are being urged to contact their representatives to express continued interest in state licensing, now that the legislature

IESA honored four Indiana TV stations for their cooperation in educating the public about good TV Service, and for airing the IESA emblem.

Packard-Bell Offers Consumer TV Course

Los Angeles—West Coast TV manufacturer Packard-Bell has announced a program of free consumer TV "servicing clinics", according to an article in *Home Furnishings Daily*. This is said to be an effort to combat the move toward state lincensing for TV repair men. According to Carl Duffy, vice president of Packard-Bell, what is needed is education rather than legislation, and the consumer clinics designed to teach the TV owner what makes his receiver operate would educate him to appreciate the work of the honest TV repair man, and detect the fraud.

Mr. Duffy emphasized that there was no intention to propose or promote do-it-yourself TV repairing, although the program might "lend emphasis to the do-it-yourself trend."

Both the Associated TV Service Technicians, as represented by Ralph Johonnot, vice president of California State Electronics Association, and Hugh Anderson, representative of the State Consumer Council, are in sharp disagreement with Duffy's approach. Said Anderson: "Duffy may be right that our legislation is not strong enough, but it is a step in the right direction".

Seattle News

Seattle, Wash.—New Television Service Association officers are Clyde Ellis, president; Art Kessler, vice president; Ray Howard, secretary, and Hal Hjelte (re-elected) treasurer.

The Seattle *TSA Service News* noted that a 22-cent service call recently advertised in the Seattle *Times* broke the previous low, 39 cents, of 10 years ago. The ad featured "space-age electronics technicians" on call from 9 am to 9 pm.

TSA Service News quotes Dun & Bradstreet as saying that a 2% profit on sales and a 10% profit on investment is the absolute minimum needed to compensate the owner of a business for the long hours, work and capital he has invested. In the past 5 years, the item went on, most retailers and service businesses have not been able to meet these figures.

NATESA Honors Zenith

Chicago—Zenith Radio Corp. was honored by the National Alliance of Television & Electronics Service Associations (NATESA) with a special "Friend of Independent Service" award.

In presenting the award at a central region meeting in Joliet, Ill., central region vice president Lyle Green said, "This award is made because of Zenith's friendly, helpful attitude toward independent service. Zenith has always cooperated fully in its service policies and training programs." The award also praised the fact that Zenith products "are designed with the serviceman in mind," Green said.

Frank Smolek, Zenith's national service director, received the award plaque on behalf of the company and announced that it would be displayed permanently in the reception room of the main plant.

Rosy Color Future

Kansas City, Mo.—The director of market research for Sylvania told regional NATESA directors that color television offers the independent service

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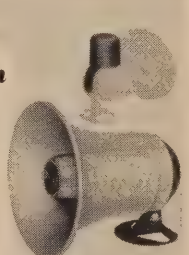

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industry its greatest challenge.

Frank W. Mansfield said, "The trend today is away from captive color TV service, which opens up a whole new area of opportunity for the competent independent serviceman." Reporting on a 3-month national survey of color-set owners and dealers, he added that captive service appears to be less prevalent now than in the early days of black-and-white TV. Many dealers reported that color service contracts are optional with the customer.

Mr. Mansfield continued: "About 70% of the dealers surveyed indicated that their customers had little or no trouble with color repairs." The public, he said, has a grossly exaggerated idea of what it costs to maintain a color set. The survey indicated that the average color set repair bill is $30.50 per year, or 9 cents a day. About 40% of set owners said the cost of color repairs was no higher than what they had experienced with black-and-white sets.

Mr. Mansfield reported that at least 90% of the 16 million new households that will spring up between now and 1977 will be in areas where they can receive colorcasts, and about 45% of those households have incomes above $6,000 annually, which makes them "prime prospects for color sets".

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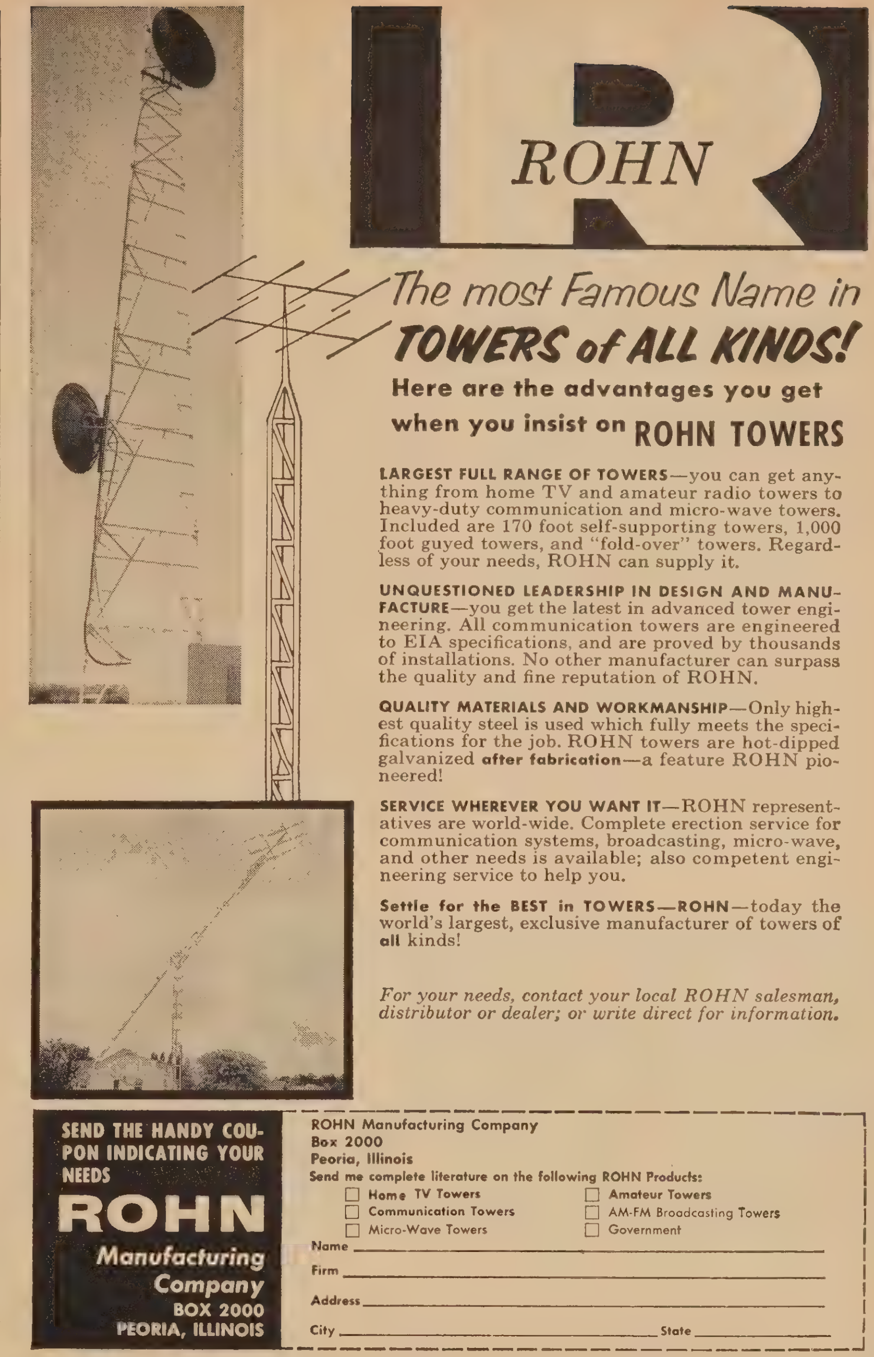
Far too many service shops base their charges on production time only. This . . . must also cover . . . rent, heat, electric power, insurances, equipment, depreciation, etc. . . . How to use that . . . time to best servicing advantage should be carefully and regularly reviewed . . . to make certain your shop is getting the most out of its most valuable commodity—*time*.

Your cash register is your time clock!—*Harold Chase, Editor, TSA News, Detroit*

Buffalo Hits Unlicensed Technicians

Buffalo, N. Y.—A campaign aimed against unlicensed TV service technicians has been started by Edward A. Grzechowiak, city license director. He said the move followed the first punitive action taken against a technician since the licensing law was set up there a year ago.

Louis J. Pikul, secretary of the television board of examiners, urged set owners to make sure their repairmen are licensed, and to obtain an itemized bill for repairs. END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Radio News	1919
Science & Invention	1920
Practical Electrics	1921
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In August, 1913, Electrical Experimenter

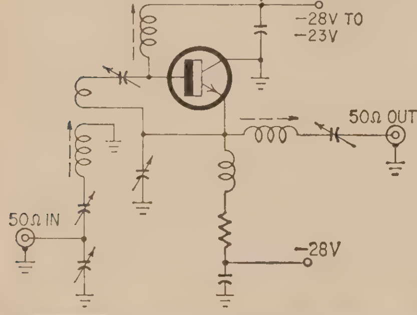
Measuring Intensity of Wireless Signals, by P. Mertz.
New System of Wireless Telegraphy.
Construction of Rotary Spark Gaps, by Henry Scott, A.M.I.R.E.
Long Distance Radio Set, by Edward A. Werner.
Improved Buzzer Telegraph, by Forrest Basset.
Magic Buzz Saw.

New Semiconductors and Tubes

2N2781, -2, -3

Vhf power transistors are bustin' out all over. Pacific Semiconductors has entered the fray with a line of three, all similar except for voltage ratings and leakage control. Prices, sadly, range from $40 to $75 apiece at the 100-up level. But that's only a matter of time. These transistors put out a *minimum* of 3.2 watts at 125 mc, from a 28-volt supply. All are housed in a compact TO-8 case. The 2N2783 is the premium transistor of the group; it has low leakage (500 μa maximum at 28 volts and 150°C ambient) and collector-to-emitter breakdown voltage of 100. These are n-p-n silicon jobs.

2N2781,2N2782,2N2783

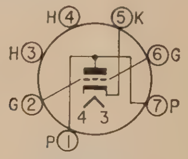


The circuit is one suggested on the PSI bulletin. Notice that it is essentially an emitter-follower arrangement, claimed to provide 3 watts at 125 mc. For more information, parts values, etc., contact Pacific Semiconductors, Inc., 14520 Aviation Blvd., Lawndale, Calif.

2DZ4, 3DZ4, 6DZ4

These are 7-pin miniature medium-μ triodes designed for uhf TV local oscillator service. They are identical except for heater ratings. The 2DZ4 and 3DZ4 have controlled heater warmup time.

Design features include silverplated base pins to minimize skin-effect losses, short leads to reduce internal inductance, and low interelectrode capacitance. Two terminals each for plate and grid are positioned to allow either series- or parallel-resonant-line operation.

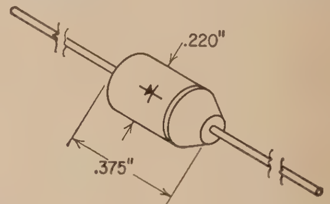


2DZ4,3DZ4,6DZ4

Typical operation at 1,000 mc is at a plate voltage of 135, a grid resistor of 10,000 ohms, and plate-circuit resistance of 2,700 ohms. Under those conditions, a 'DZ4 draws 15.5 ma plate current and 800 μa grid current. Transconductance is 6,700 μmhos. The tube is made by RCA.

New Zener diodes

A new line of Zener diodes in molded, nonconductive cases has been announced by Mallory. They are desig-



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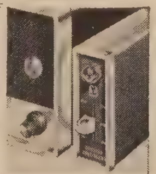

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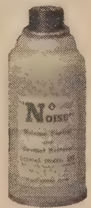

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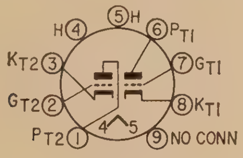
nated by *type ZA*, followed by the nominal Zener voltage. Rated at 1 watt, they are available in 5%, 10% and 20% tolerance. The 1%-tolerance and matched-pair diodes are available on request.

6GU7

A medium-μ twin-triode for general-purpose amplifying applications, the 6GU7 is intended especially for use in color TV receiver matrixing circuits.



6GU7

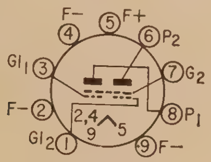
Other possibilities include phase inverter or multivibrator.

The tube, made by RCA, is in some ways similar to the venerable 12AU7, but its transconductance is slightly higher and its plate resistance slightly lower. Dissipation is up somewhat, so the 6GU7 is good for applications requiring somewhat more power and lower source-resistance. Pin connections are identical to the 12AU7's.

Details:	
Max plate volts	330
Max plate dissipation (each unit)	3 watts
Amplification factor	17
Plate resistance	5,500 ohms
Transconductance	3,100 μmhos

8348

A new push-pull vhf power tetrode, this tube boasts an "instant-heating Harp Cathode," according to Amperex. It is



8348

designed for service as a power amplifier, multiplier, driver or modulator in *transistorized* mobile equipment, and internally neutralized up to 200 mc.

The 8348 is the instant-heating version of the well known 6360. Warm-up time at rated heater voltage (1.6) is 500 msec. In ICAS service, class-C push-pull at 200 mc, the 8348 can deliver 16 watts of rf to the load with 62% efficiency. Rated plate dissipation is 6 watts per section (12 watts total). The tube is housed in a T5½ 9-pin miniature envelope.

6JH6

This is a semiremote-cutoff pentode (7-pin miniature) for agc'ed video i.f. stages. The semiremote characteristic reduces cross-modulation effects and distortion from strong signals and agc delay. At the same time, the 6JH6's high

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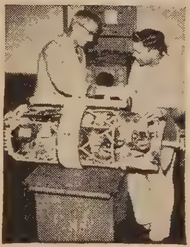
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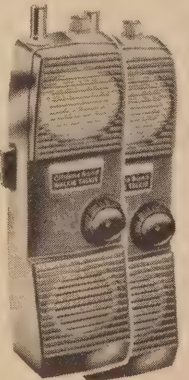
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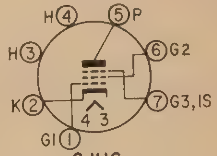
transconductance gives high stage gain.

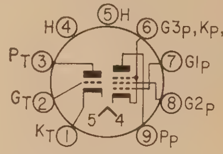
For plate and screen voltages of 125 and a cathode resistor of 56 ohms, the 6JH6's transconductance is 8,000 µmhos. The 50-µmho transconductance occurs at about −19 grid No. 1 volts. Plate current under these conditions is about 14 ma. RCA makes the tube.



6JH6

6JV8, 8JV8

These tubes combine a high-µ triode with a sharp-cutoff pentode, for all sorts of uses in TV receivers, especially ones with low B-plus. The triode is good for sound i.f., keyed agc, sync separator, sync amplifier, noise suppressor, etc., and the pentode is especially suitable as a video amplifier, according to RCA, which makes the new tube.

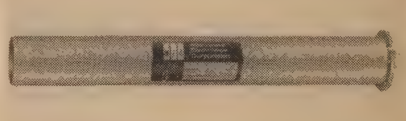


6JV8,8JV8

The pentode features 11,500 µmhos transconductance at only 125 plate volts. The triode's transconductance is 4,000 µmhos, and its amplification factor is 70.

Brief-mention department

The commonplace and the way-out meet: RCA has announced what we call a half-new tube: the 17CU5, a 7-pin miniature audio beam-power pentode, identical except for heater rating to the old 6CU5 and 12CU5/12C5. The heater is rated at 16.8 volts, .45 amp, and has a controlled warmup time for series-string use. Like its companions, it can deliver 2.3 watts with 120 volts on the plate, 110 on screen, and 8 volts peak drive.



Far less conventional is a traveling wave maser amplifier for S-band (2,300 mc) with a minimum gain of 25 db. It incorporates its own refrigeration—no need to add liquid helium—and operates at 4.2°K (4.2° above absolute zero). The amplifier is intended for microwave preamplification and radiometer work, and is made by Microwave Electronics Corp. END

noteworthy Circuits

FM Stereo Indicator

If your FM stereo multiplex tuner or adapter lacks a stereo indicator, you'll probably want to add this circuit to show when the station is broadcasting stereo. This indicator can be added to the adapter described in the December 1961 issue or to almost any other adapter.

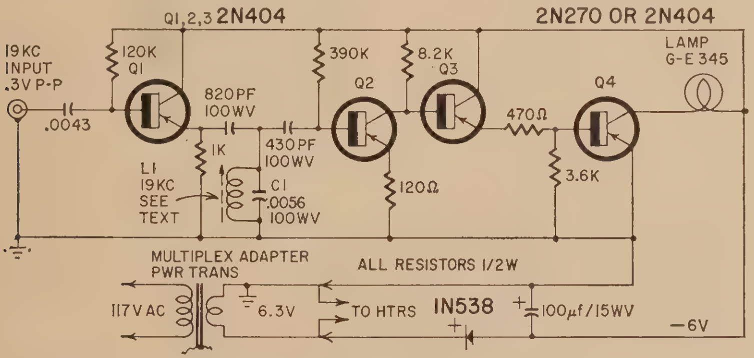
The input transistor (Q1) is an emitter follower with a high input impedance coupled to a high-Q 19-kc tank circuit (L1–C1). Voltage amplifier Q2 is biased to cutoff when there is no 19-kc input. It is coupled through emitter follower Q3 to the lamp driver (Q4). Q4 is normally biased near cutoff so the lamp is out.

When a strong enough 19-kc signal reaches Q2's base, it is amplified and used to turn on the indicator by biasing Q4 to conduction.

The power supply is a 1N538 diode and 100-μf capacitor connected as a half-wave rectifier fed by the 6.3-volt winding on the adapter's power transformer. (Note that one side of the heater winding is grounded. If your adapter has series heaters or a grounded center tap on the 6.3-volt winding, use a separate filament transformer for the power supply.)

All capacitors except the 100-μf unit are high-quality micas. L1 is a TV width coil adjusted for an inductance around 15 mh. I used a J. W. Miller type 6314. The stereo indicator is a G-E No. 345 6-volt 40-ma lamp. You may have to order it through your G-E lamp dealer. The lamp holder is a Dialco 101-3830-973. A 2N270 gives slightly greater brilliance than the 2N404 when used for Q4.

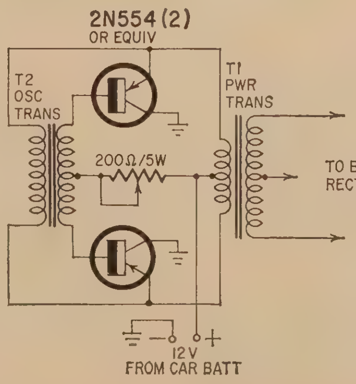
To align the indicator, connect its input to the multiplex output of your tuner and tune in a stereo broadcast. Adjust L1 slowly until the lamp lights. If it doesn't light, move the indicator's input to the plate of the composite signal amplifier in the multiplex adapter to pick up a stronger signal. The input signal must be greater than 0.3 volt peak to peak for proper operation.—*Bennett C. Goldberg*

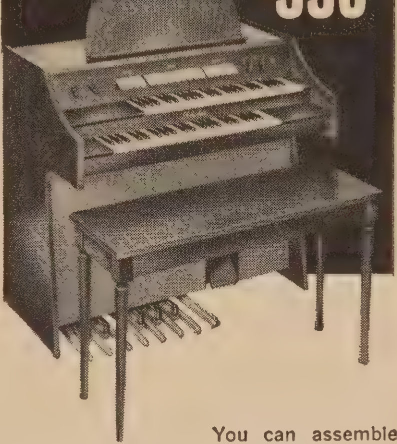


Vibrator Supply—Transistorized

This circuit will interest anyone thinking of converting an old vibrator type power supply to transistors. Its main advantages are low cost, ease of construction and reliability. It has been used to power an auto radio for over a year in temperatures ranging from 30° below to 90° above without any trouble.

T1 is the original vibrator power transformer. T2 can be almost any center-tapped interstage with a ratio of 1 to 2 up to 1 to 3.5. The 200-ohm 5-watt pot can be omitted if T2 has enough resistance to limit base current to a safe value. If the transistors are closely





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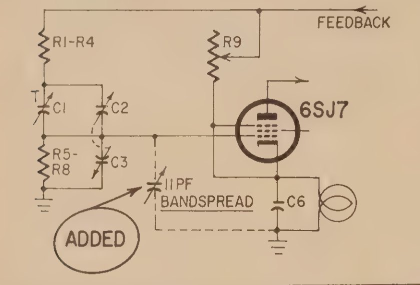
matched, connect a 220,000-ohm resistor from the base of one to ground to give enough unbalance for easy starting. The transistors can be 2N554's or any inexpensive type capable of handling the load. The collectors are grounded to the chassis so there is no need for special mountings or insulating kits.—*Arnold W. Wiegert*

Bandspread Tuning for Af Oscillator

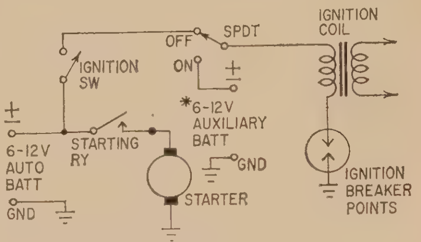
The Eico model 377 and similar Wien bridge type audio signal generators are calibrated by observing Lissajous patterns on a scope with a 60-cycle sweep. When the signal frequency is high it is very difficult to hold the patterns steady enough to count the loops. The frequency changes rapidly with a slight movement of the frequency control.

The loops can be stabilized by installing a small variable capacitor across the shunt section capacitor in the bridge. (C3 in the model 377. See simpilfied Wien bridge diagram.) I used an 11-pf capacitor (E. F. Johnson type 10L15) and mounted it just below the model and serial number on the front panel. Reverse the leads to the added trimmer if oscillations are killed—one side of the capacitor is grounded.—*Don Dudley*



Improved Quick-Start Circuits

I was very interested in the article "Start Your Car Fast" on page 48 of the December 1962 issue. After a little thought, I came up with some improvements that result in lower cost, improved reliability and independence from considerations of battery voltage and polarity and ventilation in the mounting location.

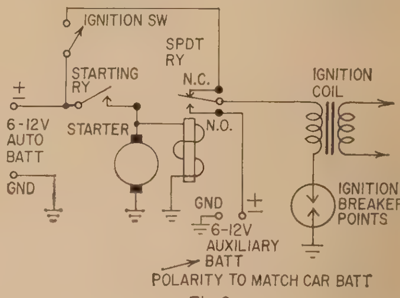


*POLARITY TO MATCH CAR BATT

Fig.1

[See correspondence on this subject on pages 21 and 18 of the February and April 1963 issues, respectively.—*Editor*]

The circuit in Fig. 1 performs the same function as the unit described in the article. It represents a saving of three transistors, three resistors, three electrolytics and a heat sink. The only part needed for this circuit that is not found in the original is the spdt switch.



POLARITY TO MATCH CAR BATT

Fig.2

Like the original, this circuit requires a separate switch to turn it off and on. This can be modified so the "quick-start" circuit is automatically controlled by the starter switch. Fig. 2 shows how a spdt relay replaces the switch in Fig. 1. The relay coil and the auxiliary battery should have the same voltage rating as the car's storage battery.—*T. E. Smithey* END

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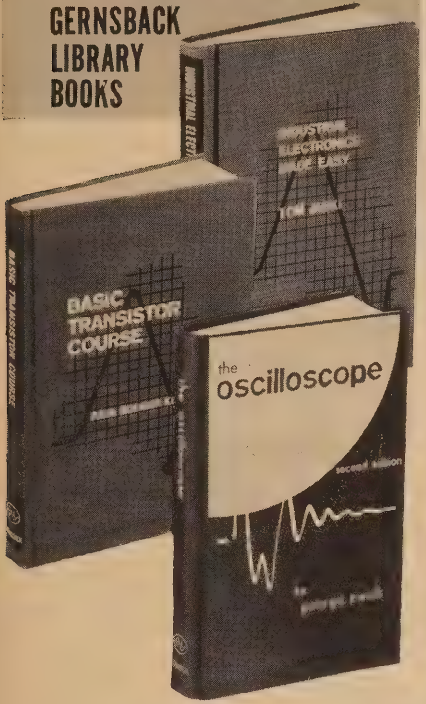

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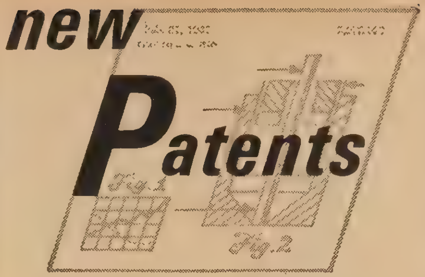


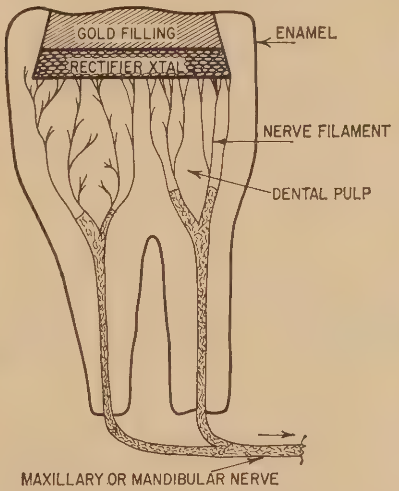
new Patents

Hearing Aid

PATENT No. 2,995,633

Henry K. Puharich, 30 East End Ave., and Joseph L. Lawrence, 570 Fort Washington Ave., New York, N. Y.

When the normal ear system is damaged, an alternate *facial system* can be utilized. A crystal diode is inserted within a live tooth where it can contact the nerves. A metal cap seals the tooth and acts as antenna.



When a nearly low-power transmitter is modulated by a mike, the signal energizes the nervous system and the subject hears sound. The output should not be greater than about 1 volt to prevent discomfort.

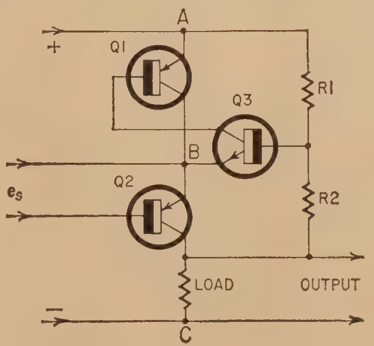
Self-Balancing Regulator Bridge

Patent No. 3,018,433

John Stone IV, Pennsauken, N. J. (Assigned to Franklin Institute of the State of Pennsylvania, Philadelphia, Pa.)

This bridge comprises similar transistors (Q1, Q2) and equal resistors (R1, R2). Emitter–base voltage is always negligible, so B may be considered a center tap between A and C (thanks to Q3), and the bridge is balanced.

If a signal e_s drives Q2's emitter more positive, Q2's impedance falls. B is no longer a center tap but goes negative to reduce Q3's impedance. Of course more current flows through Q3 and Q1. Thus Q1's impedance has been lowered to match that of Q2, but more current now flows



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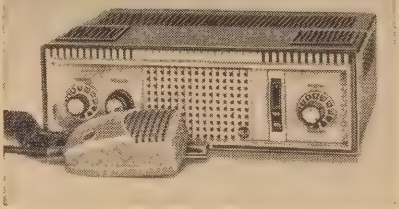

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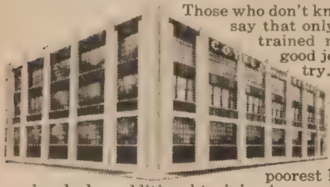

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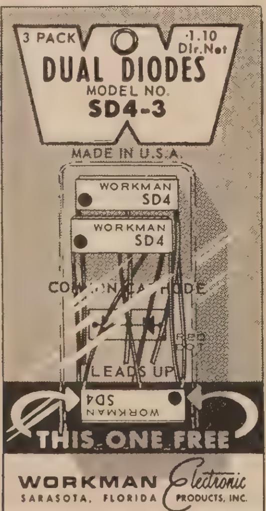

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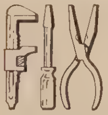

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through the load. A regulated output appears across the load.

The voltages across Q1, Q2, will remain equal, even when these transistors do not have exactly identical characteristics.

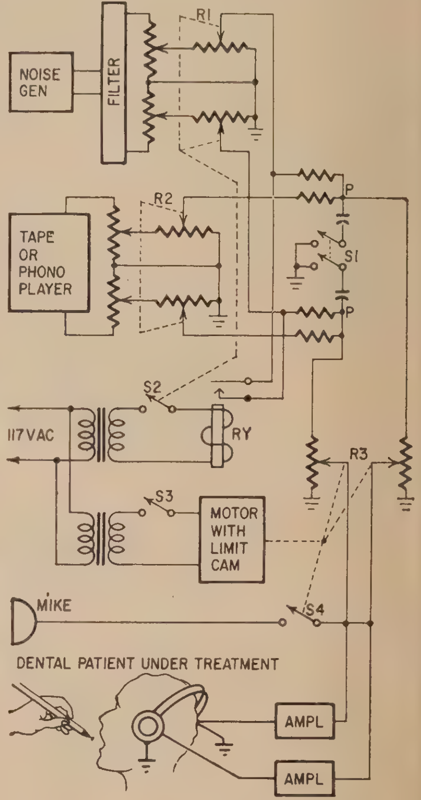
White-Noise Analgesic

Patent No. 2,986,140

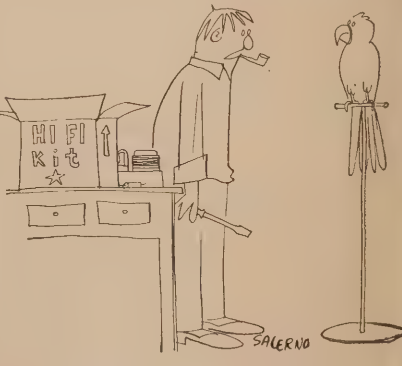
Wallace J. Gardner, Cambridge, and Joseph C. R. Licklider, Arlington, Mass.

This patent discloses how stereo music with background noise reduces tension, pain and fear during dental work. For children, animal or airplane sounds are substituted for the music. For best results, the patient should adjust the volume.

The noise should cover a wide range of frequencies. R1 sets its output. The music source may be a tape recorder, volume being set by R2. The inputs mix at P and are fed to a master control R3 to binaural headphones. The above controls are dual ganged. S1 adds capacitors to reduce high frequencies, if desired. When R1 is adjusted to minimum volume, its ganged switch S2 closes to energize a relay. The contacts short out the noise completely, preventing distracting "crosstalk".



To communicate with the patient, the dentist closes a foot switch S3. This energizes a motor which adjusts R3 to minimum volume and also closes S4. This places the microphone in the circuit.



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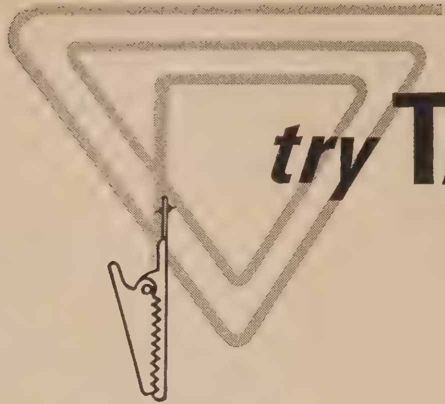

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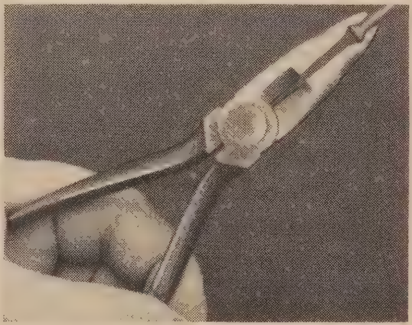
Double the Usefulness of Your Snipbills

Ordinary snipbill pliers can be made much more useful by a simple alteration. Grind or file a vee in both jaws of the tool approximately ¼ inch from the ends. If the jaws are long and thin they should be shortened somewhat to provide slightly heavier material in which to cut the vee. A pair of pliers altered this way are ideal for inserting valve keys, and for replacing or removing all types of pins and screws since the vee permits a positive grip on any small article that has a head. The vee also affords a sure grip on a square or hex head of bolt or nut and aids in holding a round object.—*Glenn F. Stillwell*



Securing Alligator Clips

Certain brands of clip leads with insulated alligator clips on each end have a habit of breaking where the clip is soldered to the stranded wire. This is especially true with the Japanese-made types of small-gage wire.

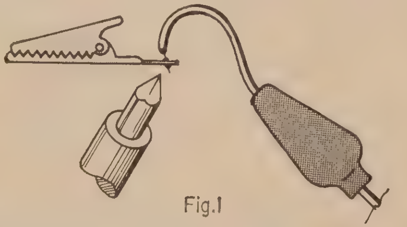


Fig.1

Fig. 1 shows the proper angle for soldering the tinned lead to the bare alligator clip. Fig. 2 shows the method of forming a loop of the insulated wire so that the strain is taken away from the soldered joint. Fig. 3 shows the loop pulled tight, and Fig. 4 shows one end of a completed test lead.—*René E. Pittet*

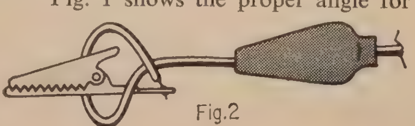


Fig.2

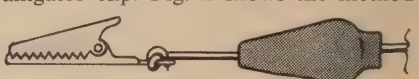


Fig.3

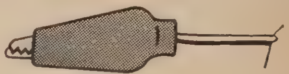


Fig.4

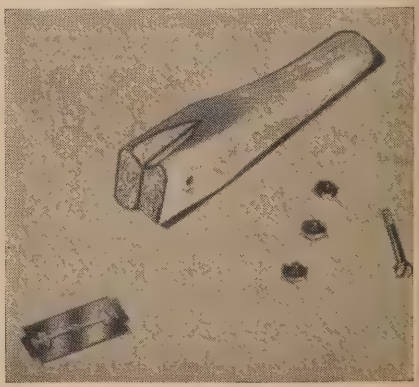
Test Tubes Before Selling

Every time you sell a new tube over the counter, say to the customer, "We want to be sure everything we sell is perfect." Then test the tube—right in front of him. You'd check out a newly repaired radio for the owner when he comes to pick it up, so why not a tube?

If a used tube shows weak and you think it ought to be replaced, but the customer isn't satisfied that it's weak enough, put a new tube in the tester, and show him how much higher it reads. A sale—without pressure!—*Allan W. Seely*

Cable Stripper

If you do considerable work with multiconductor and coax cables, this stripper will be a great time saver. It consists simply of a double-edge razor



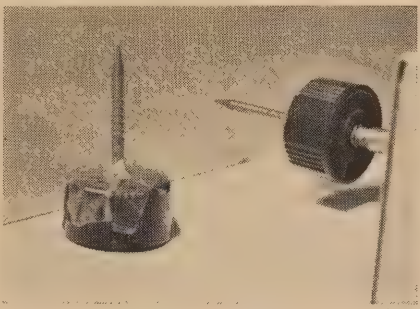
blade clamped in a slot sawed into a piece of hardwood, which serves as a handle. Two half-round depressions are gouged out (see the photo)—one ⅜-inch diameter, the other ⅝-inch. to accommodate many cable sizes.

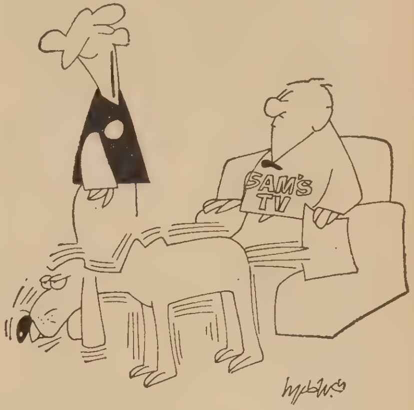
The wood is 6 x 1 x 1¼ inches. Cut the slot with a hacksaw: it makes a narrower slot than an ordinary wood saw. Cut just deep enough so that the end (unsharpened) of the blade extends slightly beyond the end of the wood. Make the rounded grooves with a rattail file, slanting them as shown. Round and smooth the handle for a comfortable grip. The blade is clamped with a machine screw, nut and washers through its center hole.

To strip cable, draw the tool slowly along the cable, then peel off the insulation. Practice a little on scrap first.
—*Robert E. Kelland*

Nail-knob Marks Shaft Holes

Try cementing or taping a nail, point out, to a control knob as a self-locating center-punch. In fact, make up a set of such knobs. Next time you have to drill a row of shaft holes for, say, a custom hi-fi installation, slip the nail-knobs onto the amplifier shafts instead of the regular knobs, and push the amplifier against the panel to be drilled. All the holes will be marked at once, and in their exact relative positions.—*John A. Comstock* END





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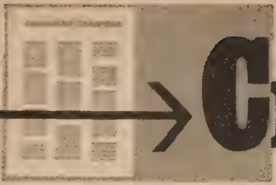

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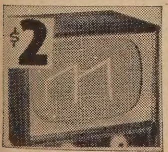

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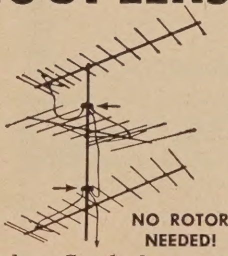
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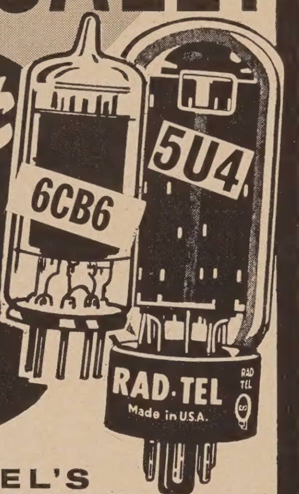

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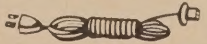

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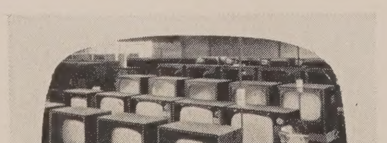

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